Description and Operating Manual

Selective Level Meter

SPM-60

for voltage level and power level measurements in the frequency range 200 Hz to 18.6 MHz

SELECTIVE LEVEL METER SPM-60

for the frequency range 200 Hz to 18.6 MHz

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Measuring Setup configurations of the series types 6 and 60

Summary of controllability of Level Generators and Level Meters

Basic units

Level Generator	PS-6	BN 340	Sweep Frequency Unit	WZ-6	BN 408
Level Generator	PS-60	BN 610	Sweep Unit	WZ-61	BN 698
Level Generator	PSS-60	BN 610/2	Decadic Control Oscillator	OD-600	BN 614[1)2)]
Level Meter	SPM-6	BN 341/4	Generator Plug-in	PSE-61	BN 690
Level Meter	SPM-60	BN 611	Fixed Frequency Plug-in	ODF-601	BN 651
Fixed Frequency Attachment	FFZ-6	BN 434			

Equipment combinations

Generator with external tuning

FFZ-6 or OD-600 → PS-6

OD-600 with BN 614/21 → PSS-60 or PS-60

Receiver with external tuning

FFZ-6 or OD-600 → SPM-6

OD-600 with BN 614/21 → SPM-60 3)

Level Measuring Setup with synchronized tuning

SPM-6, 60 → PS-6, PS-60, PSS-60

Level Measuring Setup with external tuning

SPM-6 ↑ OD-600 / FFZ-6

SPM-60 3) ↑ OD-600 +BN 614/21

\+ PS-6, PS-60, PSS-60

Swept Frequency Generator

WZ-6 / WZ-61 → PS-6, PS-60, PSS-60

Swept Frequency Measuring Setup (selective)

PSE-61 / WZ-61 → SPM-60 3)

Swept Frequency Measuring Setup with Wideband Plug-in

PS-6, PS-60, PSS-60 + WZ-6 / WZ-61

Display Unit SG-2/3

Plug-ins SGP-21/SGP-100, SGD-21, (SGH-21)

Measuring device for channel gaps 2)

PS-6, PS-60, PSS-60 ↑ OD-600/ODF-601

\+ SPM-6, SPM-60 3) ↑ OD-600/ODF-601

Applications

Pilot level measurements while lines are actually carrying traffic

Level measurements at repeated measuring frequencies in production and test departments

Controlling equipment

Attenuation and gain measurements.

Attenuation and gain measurements at repeated measuring frequencies (e.g. checking frequency response in test departments).

Impairment line search and Hot Tone Scanning on transmission systems. Frequency response with recorded plot or chart.

End-to-end swept frequency measurements (without auxiliary connections);

Swept frequency measurements in test departments.

Automatic selective end-to-end swept frequency measurements (without auxiliary connections).

Swept frequency measurements in test departments.

Measurements of translators with offset frequencies.

1) Frequency setting direct or by means of ODF-601
2) BN 614/21 is required for operating the OD-600 with PS-60/SPM-60
3) Commencing with series H

INTRODUCTION

The Selective Level Meter SPM-60 ist characterized by high level measuring accuracy, selectivity, sensitivity, and ease of use. The single tuning range for frequencies, which extends from 200 Hz (2 kHz) to 18.6 MHz, also contributes to this ease of use. For this reason, the unit is particularly suitable for measurements on wideband carrier frequency systems, this type of tuning being especially useful for searching for noise within the range of carrier frequency transmission via radio links or for analysis of frequency spectra.

In addition, the equipment versions BN 611/5 and BN 611/8 are equipped with a new type of quartz-stabilized frequency lock, which guarantees very high long-term stability of the selected frequency, thus major advantages are obtained in particular for continuous monitoring of pilot frequencies or for checking data channels in FDM systems with respect to phase jitter measurements because the lock circuit reduces the intrinsic phase jitter when the frequency is locked. In addition, the versions BN 611/5 and BN 611/8 have a pilot filter with an effective noise bandwidth of 24 Hz in order to permit measurement, for example, of group and supergroup pilots with a narrow bandwidth, even while the channels are carrying traffic.

A further feature for simplifying operation is the automatic calibration that guarantees the level measuring accuracy, but which can be switched off if the measurements require it. The state "calibration cycle off" is indicated by a red warning lamp.

The built-in overload monitor permits easy detection of incorrect measurements resulting from overloading the receiver, thus these can be avoided. The effective noise bandwidth of the SPM-60 can be switched between 1.74 kHz and 400 Hz (with an additional bandwidth of 24 Hz for the pilot level meter).

The demodulator output can be switched for upright or inverted position of the signal and the output frequency can also be switched between 1 kHz and 2 kHz. The 1 kHz frequency is used mainly for phase jitter measurements, for example with the W & G Data Circuit Test Set DLM-1. (See Section 2.3.3.10. in the operating instructions).

The 2 kHz frequency, in contrast, is intended primarily for measuring interruptions in accordance with CCITT. The single sideband demodulator also permits monitoring of the modulation in the channel being measured. For high impedance and low capacitance measurements, either the passive Probe TK-9 or the active Probe TK-12 with power supply unit can be used.

A fast signal detector with indicator lamp simplifies the search for unknown frequencies when the level meter is tuned rapidly through the range. The tuned frequency is displayed on a 6-digit frequency counter (maximum resolution 10 Hz), whose bright and flicker-free numerical display is easily read even under unfavorable conditions.

The measuring range of the unit can be switched between + 20 dB and - 110 dB (or + 26 dBm and - 100 dBm), referred to the 0 dB indication, with only a single knob. The result of the measurement is displayed by an analog meter with the 3 switchable ranges 20 dB, 2 dB, and ± 0,5 dB (level magnifier). This level magnifier permits even minimum level deviations of 0.01 dB to be detected. The input impedance of the equipment versions BN 611/0 and /5 can be switched between 75 Ω and high impedance.

In the versions BN 611/6 and /8, the SPM-60 is additionally equipped with a balanced input section for frequencies from 2 kHz to 1.6 MHz, with an internal impedance which can be switched between 50, 60, 65, 75, 124, 135, 150 Ω, and high impedance. Units with a bandwidth of 24 Hz (BN 611/5 and /8), in contrast, permit measurements of frequencies as low as 200 Hz.

The Level Meter SPM-60 can be combined with one of the Signal Generators PS-60, PSS-60, or PS-6 to form a complete level measuring set. The generator frequency can be tuned synchronously from the SPM-60 via an auxiliary connection if the generator and receiver are operated at the same location.

In addition, the Control Oscillator OD-600, if fitted with an additional carrier board (option BN 614/21), permits decadic frequency tuning of the Selective Level Meter SPM-60 with smallest steps of 1 Hz. If measurements are repeatedly made at fixed frequencies, it is advantageous to fit the OD-600 with the Fixed Frequency Plug-in ODF-601, on which up to 26 preprogrammed fixed frequencies can be selected with a rotary switch. In addition, the ODF-601 can be switched

to an automatic cycle, with facilities for skipping specific fixed frequencies. It is also possible to carry out measurements with frequency offset and automatic selective line measurements without additional synchronization, even under operational conditions, or to tune the frequency continuously with option BN 614/23 or to remotely control the Control Oscillator, for example in automatic measuring sets, by means of the remote control circuit board BN 614/22.

Together with the Sweep Adapter WZ-61 and an XY recorder, the Level Meter is also suitable for sweep frequency measurements.

Measurements of the return loss or signal balance ratio (in accordance with CCITT Recommendation O. 121) can be carried out with the Measuring Attachments RFZ-5 (coaxial above 10 kHz), RFZ-12 (coaxial up to 4.5 MHz and balanced), and SDZ-12.

Due to the compatibility of the units of the series 6 with those of series 60, the most suitable test setup for the measuring task can be selected (see also the test setup configurations of the type series 6 and 60).

The SPM-60 can be operated either from the mains power supply or independently of the supply by means of the Inverter WR-420 and an external battery.

1. SPECIFICATIONS

Unless otherwise stated, the specifications are valid for the permissible range of a.c. line voltage for the rated range of use of the temperature immediately after the set is switched ON.

1.1. Frequency range

Unbalanced . . . . . 200 Hz to 18.6 MHz[1)]

Balanced (BN 611/6 and 611/8)
Z_o = 124, 135, 150 Ω . . . . . 1 kHz to 1.6 MHz[1)]
Z_o = 600 . . . . . 200 Hz to 300 kHz[1)]

Frequency setting . . . . . continously tunable through the entire range with coarse-fine drive

Additional fine detuning/retuning, mean detuning range
for BN 611/0 and /6 . . . . . approx. ± 800 Hz
for BN 611/5 and 611/8 . . . . . approx. ± 50 Hz

Frequency display . . . . . through frequency counter with 6 digit, flicker-free illuminated numeric display

Frequency resolution, switchable . . . . . 1 kHz, 100 Hz, 10 Hz
Measurements/sec 77, 8, 3.3

Error limits of frequency reading within the rated operating range of ambient temperature . . . $\leqq \pm 9 \cdot 10^{-6} \pm 1$ digit of the last displayed position

Frequency lock circuit (with BN 611/5 and 611/8)

Temperature coefficient of tuned frequency in locked state, in limits range of use of ambient temperature. . . $\leqq (\pm 5 \cdot 10^{-7} \pm 0.9$ Hz)/K

1.2. Level reading

With automatic amplitude calibration, switchable to voltage level (0 dB ≙ 0.775 V) or power level (0 dBm ≙ 1 mW into Z_o)

Measuring ranges
for 0 dB meter reading . . . . - 110, - 100, - 90, - 88, - 86, to, + 20 dB
- 100, - 90, - 80, - 78, - 76, to, + 26 dBm

Meter scales
Scale range 20 dB . . . . . - 22 to + 1 dB
Scale range 2 dB . . . . . - 2.2 to + 0.3 dB
Scale range ± 0.5 dB (level magnifier) . . . . . - 0.5 to + 0.5 dB

Smallest readable level difference
Scale range 2 dB . . . . . 0.02 dB
Scale range ± 0.5 dB . . . . . 0.01 dB

Level magnifier (for relative measurements)
setting range of gain . . . . . approx. 2.5 dB

Fast signal detector
Threshold referred to 0 dB meter reading
in scale range 20 dB . . . . . approx. - 20 dB
in scale range 2 dB . . . . . approx. - 2.1 dB

Error limits of input level reading
Error limits of level reading in range 0 dB (+ 10 dBm)[2]
at 0 dB reading in scale range 2 dB and at + 20 °C

unbalanced
f = 20 kHz to 6 MHz . . . . . ± 0.10 dB
f = 2 kHz to 18.6 MHz . . . . . ± 0.15 dB
f = 200 Hz to 18.6 MHz . . . . . ± 0.40 dB[1]

balanced
with a source impedance $Z_s = 600\ \Omega$, input impedance $Z_{in} = 600\ \Omega$ or $Z_s = 300\ \Omega$, Z_{in} bridged
f = 1 kHz to 200 kHz[1] . . . . . ± 0.30 dB
f = 200 Hz to 300 kHz[1] . . . . . ± 0.50 dB

with $Z_s = Z_o = 124\ \Omega$ to $150\ \Omega$, $Z_{in} = Z_o = 124\ \Omega$ to $150\ \Omega$ or $Z_s = Z_o/2$, Z_{in} bridged
f = 1 kHz to 620 kHz[1] . . . . . ± 0.40 dB
f = 1 kHz to 1.6 MHz[1] . . . . . ± 0.60 dB

Variation with frequency in the level ranges
- 90 dB to + 10 dB (- 80 dBm to + 20 dBm), referred to f = 20 kHz

unbalanced
f = 2 kHz to 18.6 MHz . . . . . ≦ ± 0.10 dB

balanced
with $Z_s = Z_o = 124$ to $150\ \Omega$, $R_e = 124$ to $150\ \Omega$
f = 2 kHz to 620 kHz . . . . . ≦ ± 0.25 dB

Error limits of measurement range switch for f = 2 kHz to 18.6 MHz
referred to setting 0 dB (+ 10 dBm) in ranges[3) 4) 6)]
- 90 dB to + 8 dB (- 80 dBm to + 18 dBm) . . . . . ± 0.05 dB
+ 10 to + 20 dB (+ 20 to + 26 dBm) . . . . . ± 0.08 dB
- 100 dB, - 110 dB, (- 90 dBm, - 100 dBm) . . . . . ± 1 dB

Error limits of meter scale referred to 0 dB scale mark
Scale range 20 dB . . . . . ± 1 % f.s.d.
Scale range 2 dB . . . . . ± 0.03 dB
Scale range ± 0.5 dB . . . . . ± 0.015 dB

Max. average temperature coefficient in limits range of operation of ambient temperature to + 20 °C at 0 dB meter reading:
in scale range 2 dB . . . . . ≦ ± 0.005 dB/K
in scale range ± 0.5 dB . . . . . ≦ ± 0.007 dB/K

Uncertainty of meter reading due to superimposed noise in the scale ranges 2 dB and ± 0.5 dB with "slow" meter readings and at 75 Ω input impedance

Measuring ranges: - 90 to + 8 dB (- 80 to + 18 dBm) . . approx. ± 0.005 dB
+ 10 to + 20 dB (+ 20 to + 26 dBm) . . approx. ± 0.015 dB
- 100, - 110 dB (- 90, - 100 dBm) . . approx. ± 0.15 dB

Deflection caused by noise with open input,
50 to 600 Ω input impedance, f ≧ 6 kHz and bandwidth 1.74 kHz
in position: - 90 dB (- 80 dBm) . . . . . ≦ - 112 dB (- 102 dBm)
- 100 dB (- 90 dBm) . . . . . ≦ - 122 dB (- 112 dBm)
- 110 dB (- 100 dBm) unbalanced . . . ≦ - 126 dB (- 116 dBm)
balanced . . . . ≦ - 123 dB (- 113 dBm)

1.3. Measuring inputs

Input with BN 611/0 and /5 unbalanced, connector Versacon ® 9

Input impedance, switchable . . . . . 75 Ω and 10 kΩ II approx. 45 pF

Return loss coefficient at input impedance 75 Ω
in range - 100 dB to + 20 dB (- 90 dBm to + 26 dBm) . . . . . ≦ 0.02
in range - 110 dB (- 100 dBm) . . . . . ≦ 0.05

Inputs with BN 611/6 and /8 unbalanced, connector Versacon ® 9
and balanced, 3pole CF connector.

Input impedance
switchable, unbalanced . . . . . 50, 60, 65, 75, 124, 135, 150 Ω
and 10 kΩ II approx. 45 pF
balanced . . . 124, 135, 150, 600 Ω and approx. 8 kΩ II 0.7 H

Return loss coefficient at R_e = 50 to 75 Ω, unbalanced
in position - 100 dB to + 20 dB (- 90 dBm to + 26 dBm) . . . . . ≦ 0.02
- 110 dB (- 100 dBm) . . . . . ≦ 0.06

with R_e = 124 to 150 Ω, unbalanced, f ≦ 1.5 MHz . . . . . ≦ 0.01

Signal balance ratio at f ≦ 620 kHz . . . . . ≧ 35 dB[5)]

Permissible input voltage (overload point) for all inputs

at input impedance 50 to 600 Ω . . . . . V_{rms} ≦ 10 V
at input impedance 10 kΩ, a.c. voltage . . . . . V_p ≦ 25 V
d.c. voltage . . . . . V ≦ 42 V

1.4. Selectivity

Switchable
"Wide", f = 2 kHz to 18.6 MHz

3 dB bandwidth	2.3 kHz
Equivalent-noise bandwidth	1.74 kHz
Rejection at $\Delta f \geqq \pm 2$ kHz	$\geqq$ 60 dB

"Narrow", f = 2 kHz to 18.6 MHz

3 dB bandwidth	.500 Hz
Equivalent-noise bandwidth	.400 Hz
Rejection at: $\Delta f \geqq +1$ kHz	$\geqq$ 30 dB
$\Delta f \geqq \pm 2$ kHz	$\geqq$ 60 dB

Pilot filter (with BN 611/5 and /8, f = 200 Hz to 18.6 MHz)

3 dB bandwidth	.approx. 30 Hz
Equivalent-noise bandwidth	.approx. 24 Hz
Rejection at: $\Delta f \geqq \pm 70$ Hz	$\geqq$ 26 dB
$\Delta f \geqq \pm 80$ Hz	$\geqq$ 28 dB
$\Delta f \geqq \pm 200$ Hz	$\geqq$ 40 dB
$\Delta f \geqq \pm 1$ kHz	$\geqq$ 70 dB
If suppression	$\geqq$ 80 dB
Image frequency rejection	$\geqq$ 80 dB

1.5. Self introduced harmonic ratio

Self introduced harmonic ratio in the settins "low distortion" for input level $\leqq$ + 10 dB (+ 20 dBm) for k_2 and k_3 with a 50 dB increase of sensitivity referred to the fundamental frequency measuring range:

unbalanced,	f $\geqq$ 300 kHz	$\geqq$ 75 dB
	f = 2 kHz to 300 kHz	$\geqq$ 65 dB
balanced	f $\geqq$ 300 kHz	$\geqq$ 75 dB
	f = 2 kHz to 300 kHz	$\geqq$ 60 dB

Low distortion ranges . . . . - 30, - 50, - 70, - 90, - 100 and - 110 dB
- 20, - 40, - 60, - 80, - 90 and - 100 dBm

The SPM-60 has a push button for checking linearity.

1.6. Outputs and control inputs

Unbalanced, short-circuit proof

D.C. voltage output, 3pole CF connector	Z_{out} = 5 kΩ
Open circuit voltage for 0 dB meter reading	V = 4.3 V

Demodulator output, 3pole CF connector . . . . . Z_{out} = 600 Ω
Output voltage for 0 dB meter reading . . . approx. 0 dB with 600 Ω load

Output frequency with tuning to filter centre,
switchable . . . . . 1 kHz, 2 kHz
Single sideband demodulation
switchable . . . . . upright or inverted position

Calibration clock, ON/OFF switch;
signal lamp for switched-off state

Intrinsic phase jitter of the demodulator output voltage
(only with BN 611/5 and /8) conforming with CCITT Rec. O. 91

in locked state of frequency tuning
at bandwidth 1.74 kHz, output frequency 1 kHz,
measuring range switch in the positions - 72, - 52, - 32 to + 20 dB
(- 62, - 42, - 22 to + 26 dBm), meter reading - 12 dB to 12 dB overload

for f = 6 kHz to 1 MHz . . . . . ≦ 1 °
for f = 6 kHz to 18.6 MHz . . . . . ≦ ± 1.5 °

Control output Bu 2401, Z_{out} = 75 Ω . . . . V_{rms} = 40 mV at 75 Ω load
(remote tuning of the PS-6, PS-60 or PSS-60
with carrier signal 24 to 42.6 MHz)

Control output Bu 2402, Z_{out} = 75 Ω . . . . . V_{rms} = 200 mV at 75 Ω load
(remote tuning of the PS-6, PS-60 or PSS-60
with standard frequency 1 MHz)

Input for remote tuning Bu 3301, Z_{in} = 75 Ω . . . V_{rms} = 40 to 150 mV
(Remote tuning of the instrument with carrier signal
24 to 42.6 MHz)
The tuned frequency is indicated at the counter display
Suitable control oscillator: OD-600, BN 614 with option BN 614/21

1.7. General Specifications

Tolerable ambient temperature

Limits range for storage and transport . . . . . - 40 °C to + 60 °C
Limits range of use . . . . . - 10 °C to + 50 °C
Rated range of use . . . . . + 10 °C to + 35 °C

Power supply . . .

a.c. line voltage, adjustable	rated range of use
110 V	93.5 V to 121 V
117 V	100 V to 129 V
127 V	109 V to 141 V
220 V	187 V to 242 V
227 V	193 V to 250 V
235 V	202 V to 262 V

Rated range of use of a. c. line frequency . . . . . 45 to 440 Hz
Power consumption . . . . . approx. 20 VA
Safety class I
Battery operation via WR-420 (mounted on back panel)
Specifications, see para. 1.8.3.

Dimensions .	Bench model		19" rack mounting (DIN 41 494)	
	Width with handles	478 mm	Width	443 mm
	Height overall	199 mm	Height	176 mm
	Depth with handles	407 mm	Depth	353 mm

Weight . . . . . 19.5 kg

---

1) At f = 200 Hz or in frequency range 1 kHz to 2 kHz with bandwidth 24 Hz (BN 611/5 or BN 611/8)

2) At 24 Hz bandwidth, the error increases by ≦ ± 0.05 dB, with the appearance of a discrete impairement level at the order of magnitude of the measuring level, separated ≧ ± 70 Hz from the measuring signal, by an additional ≦ ± 0.02 dB (increased error).

3) With synchronized control of the Generator from the Level Meter and with reading the send level, the specified error increases by less than 0.03 dB.

4) In frequency range f = 2 kHz to 6 kHz, the error increases by 0.04 dB.

5) The receiver balance ratio is measured by connecting a center tapped choke coil across the input terminal a-b of the receiver. The receiver input is terminated with an internal resistor of Z = 150 Ω. Then, a signal generator is connected via Z/4 = 37.5 Ω between earth and the center top of the clock coil. The receiver balance ratio of the Level Meter is obtained from the level difference between Generator and Receiver being tested.

6) At 24 Hz bandwidth, the error of the measuring range switch increases by ≧ ± 0.02 dB.

7) At carrier voltage < 100 mV, the error limits of level indication increase by ≧ ± 0.03 dB.

1.8. Measuring accessories

1.8.1. Test probe TK-9

Unless otherwise stated, the specifications are valid for an ambient temperature of 20 °C.

Frequency range	50 kHz to 18.6 MHz
Input levels	
Maximum tolerable AC voltage	8 V
Maximum superimposed DC voltage	42 V
Attenuation with 75 Ω load:	
50 kHz to 13 MHz	20 dB ± 0.1 dB
Up to 15 MHz	20 dB + 0.1/- 0.25 dB
Up to 18.6 MHz	20 dB + 0.1/- 0.5 dB
Input impedance	approx. 5 kΩ II 17 pF
Intrinsic harmonic ratio at 0 dB (0.775 V)	
Input level for K_2 and K_3	110 dB
Tolerable ambient temperature for operation	- 10 to + 50 °C
Attenuation variation with ambient temperature	≦ 0.01 dB/10 °C

Connector: Universal socket Versacon ® 9 for all common plug adapters or test prod

1.8.2. Test Probe TK-12 with Power Supply Unit TKN-12

Unless otherwise stated, the specifications are valid for the rated ranges of use of the temperature and mains voltage, together with the Selective Level Meter SPM-60.
The mains Power Supply TKN-12 is required for power supply of the probe. The Level Meter is operated in the high impedance setting.

1.8.2.1. Test Probe TK-12

Frequency range, unbalanced	200 Hz to 18.6 MHz
balanced (with CF plug S 804)	200 Hz to 2 MHz
Input levels	
Maximum measurable	0 dB
Maximum tolerable AC voltage V_{rms}	10 V
Maximum tolerable DC voltage	42 V
Gain, adjustable	0 dB
Variation of gain with temperature	approx. 0.02 dB/10 °C

Intrinsic frequency response of the probe, referred to 1 MHz

Unbalanced	300 Hz to 2 MHz	± 0.05 dB
	200 Hz to 2 MHz	± 0.1 dB
	200 Hz to 4.5 MHz	± 0.2 dB
	200 Hz to 18.6 MHz	± 0.45 dB
Balanced	200 Hz to 2 MHz	± 0.1 dB

Input impedance

Unbalanced, real component at 10 kHz	approx. 1 MΩ
Input capacitance	approx. 15 pF
Balanced, real component 10 kHz	approx. 1 MΩ
Input capacitance	approx. 25 pF

Harmonic ratio for k_2 and k_3

Input level 0 dB and f = 20 kHz	≧ 50 dB
Input level 0 dB and f = 6 MHz	≧ 40 dB

Balance

Signal balance ratio in the range 200 Hz to 2 MHz	≧ 40 dB

Measured in accordance with CCITT Recommendation O. 121

Common mode voltage	≦ 2 Vp
Connector, unbalanced	Universal connector Versacon ® 9 with adapters for plugs 2.5/6, 1.6/5; 6; BNC; 1.6/10; 4/13, Western 358 A, Western 440 A, or test prod with chassis ground clamp
Connector, balanced, optional accessory	Balanced CF plug S 804
Dimensions of the test prod in mm	14 Ø x 150
Weight of the test probe TK-12	350 g
Cable length	approx. 1.2 m
Power supply for TK-12	Probe Power Supply TKN-12

1.8.2.2. Power Supply TKN-12

Mains voltage as for SPM-60 (see 1.7.)

Mains frequency	45 to 65 Hz
Power consumption	approx. 7 VA
DC output voltage, short-circuit-proof	24 V/80 mA
Dimensions, w x h x d, in mm	110 x 50 x 150
Weight	850 g

1.8.2.3. General specifications

Tolerable ambient temperature

Rated range of use	+ 10 to + 35 °C
Operating range limits	0 to + 45 °C
Range limits for storage and transport	- 25 to + 60 °C

1.8.3. Inverter WR-420

Rated operating conditions
The rated operating conditions describe those operating conditions (or any combination of these) for which the specified error limits are valid.

DC voltage [1] at the input

Rated ranges of use	Range	Rated value/V	Voltage range/V
	I	12	11 to 15
	II	24	22 to 29
	III	36	33 to 45
	IV	48/60	44 to 68 max.[4]

Output power at rated voltage and with resistive load; . . . . . ≦ 15 W
at rated voltage and with a rectifier load[3] . . . . . ≦ 20 VA

Ambient temperature
when mounted on rear of unit, without cover . . . . . - 10 to + 55 °C
when mounted on rear of unit with transport case cover . . - 10 to + 35 °C

Warming up time . . . . . ≦ 5 min

Ambient temperature for storage and transport . . . . . - 40 to + 70 °C

AC voltage at output, floating, sinusoidal . . . . . 117/220 V ± 10 %[2]
Frequency . . . . . 400 Hz ± 10 %[2]

Efficiency at 24 V input voltage and 15 W
output power (resistive load) . . . . . ≧ 0.5[1]

VDE 0411 protection class I

Dimensions, w x h x d, in mm . . . . . 170 x 53 x 65
Weight . . . . . 0.9 kg

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1) DC voltage minus the peak value of the superimposed AC voltage

2) This value includes the variations with temperature, load (0 to 15 W), and DC input voltage, including range switching.
The error limits of the rms value of the output voltage (± 10 %) is referred to the selected output voltage of 117/220 V ± 1 % with an output power of 15 W and an input voltage of 13.5 V.

3) This is defined as a load in which the major part of the consumed power was converted into a DC voltage by means of rectifier circuits.

4) DC voltage plus the peak value of the superimposed AC voltage.

1.8.4. Return Loss Measuring Attachment RFZ-5

Z values . . . . . 50, 60, 65, 75, 135 and 150 Ω
Frequency range for Z = 50, 60, 65, 75 Ω . . . . . 10 kHz to 36 MHz
for Z = 135 and 150 Ω . . . . . 10 kHz to 5 MHz

Maximum measuring error of the reflection coefficient, r, at Z = 75 Ω
from 10 kHz to 5 MHz . . . . . ± 0.01 r ± 0.0015
above 5 MHz to 15 MHz . . . . . ± 0.03 r ± 0.003
above 15 MHz to 36 MHz . . . . . ± 0.05 r ± 0.005

Input and output impedance of the bridge . . . . . 75 Ω

Attenuation at r = 1 . . . . . 47 dB

Dimensions (w x h x d) in mm . . . . . 140 x 40 x 90
Weight . . . . . 310 g

Standard accessories . . . . . 1 Transport case
2 Cables, Z = 75 Ω (generator and receiver cables)
1 Termination resistor R_N, 75 Ω (M)
1 Termination resistor R_N, 75 Ω (F)
2 Measuring cables 25 cm long, Z = 75 Ω
1 Return loss standard R_E, 75 Ω (F)
Option accessories . . . . . 50/60/65/135 and 150 Ω version
(further details on request)
2 Adapters each (generator and receiver cables) for 4/13 and BNC
1 Adapter each for R_x with 4/13 (M), 4/13 (F), BNC (M) and BNC (F)

(M) = Plug connector; (F) = Socket connector

1.8.5. Return Loss Measuring Attachment RFZ-12

Frequency range . . . . . 200 Hz to 4.5 MHz

Standard resistors installed,
can be switched to balanced . . . . . 124, 135, 150, 600 Ω
unbalanced . . . . . 75, 124, 135, 150, 600 Ω

Attenuation at r = 1
for balanced object being measured . . . . . 40 dB
for unbalanced object being measured . . . . . 46 dB

Maximum measuring error of the reflection coefficient, r, in balanced mode
from 200 Hz to 620 kHz for Z = 124 Ω to 150 Ω . . . . . ± 0.1 r ± 0.001
from 200 Hz to 2 MHz 124 Ω to 150 Ω . . . . . ± 0.1 r ± 0.003
from 200 Hz to 4.5 MHz 124 Ω . . . . . ± 0.2 r ± 0.006
from 200 Hz to 620 kHz 600 Ω . . . . . ± 0.1 r ± 0.003

In unbalanced mode
from 200 Hz to 620 kHz to Z = 75 Ω to 150 Ω . . . . . ± 0.1 r ± 0.001
from 200 Hz to 2 MHz 75 Ω to 150 Ω . . . . . ± 0.1 r ± 0.002
from 200 Hz to 4.5 MHz 124 Ω to 150 Ω and r ≦ 0.1 . . ± 0.2 r ± 0.003
from 200 Hz to 4.5 MHz 75 Ω . . . . . ± 0.1 r ± 0.003

Dimensions w x h x d, in mm, without plug . . . . . 75 x 56 x 133
Weight . . . . . approx. 430 g

Standard accessories . . . . . Balanced CF adapter BN 810/00.01 (M)
for connection of the object to be measured
Optional accessories . unbalanced adapter with Versacon (R) 9 BN 810/00.06
Further adapters on request
Transport case

(M) = Plug connector

1.8.6. Signal Balance Ratio Measuring Attachment SDZ-12

Frequency range . . . . . 200 Hz to 4.5 MHz

Termination and Z/4 resistors fitted,
can be switched to . . . . . 124, 135, 150, 600 Ω

Intrinsic signal balance ratio
from 200 Hz to 520 kHz to Z = 124 Ω to 150 Ω . . . . . ≧ 60 dB
from 200 Hz to 2 MHz 124 Ω to 150 Ω . . . . . ≧ 54 dB
from 200 Hz to 4.5 MHz 124 Ω to 150 Ω . . . . . ≧ 50 dB
from 200 Hz to 120 kHz 600 Ω . . . . . ≧ 60 dB

Dimensions in mm (w x h x d), without plug . . . . . 75 x 62 x 125
Weight . . . . . 650 g

Standard accessories . . . . . Balanced CF adapter BN 810/00.01 (M)
for connection of the object to be measured
Optional accessories . . . . . Transport case
Further adapters on request

(M) = Plug connector

1.8.7. Decadic Control Oscillator OD-600 and Frequency Plug-in ODF-601

Unless otherwise specified, the data are valid for the rated ranges of use of ambient temperatures, of mains voltage and mains frequency, and for the frequency range 60 kHz to 18.6 MHz after a warming up period of 10 minutes.

1.8.7.1. Decadic Control Oscillator OD-600

Decadic frequency setting
with 8 rotary switches . . . . . 0 to 19.999 999 MHz
Smallest frequency step . . . . . 1 Hz
Error limits of the frequency
when operated with carrier frequency board option BN 614/21
and controlling the PS-6, PS-60, PSS-60, PSE-61 . . . . 1 Hz ± $2 \cdot 10^{-6}$ 1)
Aging . . . . . approx. + $1 \cdot 10^{-6}$/year

1) Series A: ± $3 \cdot 10^{-6}$

when controlling the SPM-60 or a test setup consisting of PS-60 (PSS-60) and SPM-60, or when operating the basic unit with PS-6, SPM-6 or a test setup consisting of PS-6, and SPM-6, at 20 °C . . . . . 1 Hz ± 3 · 10^{-6}
average temperature coefficient . . . . . ± 4 · 10^{-7}/K
aging . . . . . approx. ± 1 · 10^{-6}/year

Continuous frequency tuning (option) with decadically set reference frequency, fine tuning by means of drum scale
4 ranges . . . . . - 30 to + 100 Hz/- 0.3 to + 1 kHz/
- 3 to + 10 kHz/- 30 to + 100 kHz
Additional frequency error . . . . . ± 4 % of full scale value
Fine detuning in the same ranges by means of an external voltage across Z_{in} approx. 50 Ω . . . . . - 1.5 V to + 5 V

Remote control frequency (option). . 8-4-2-1 BCD code, negative TTL logic

Tuning speed, frequency error after	20 ms	100 ms	350 ms	500 ms
for a jump of ≦ 1 MHz	≦ 30 Hz	≦ 15 Hz	≦ 2 Hz	≦ 1 Hz

Spectral purity
referred to the output signal of PS-6, PS-60, PSS-60, PSE-61:
The values specified for these units apply.

Outputs
Internal standard frequency . . . . . 1 MHz

Interpolation frequency. . . . . 3 to 4 MHz
for the signal generator PS-6 and the selective level meter SPM-6

Tuning voltage for the locking oscillators in PS-6 and SPM-6

Carrier frequency with option BN 614/21 . . . . . 24 to 42.6 MHz
for control of the signal generator PS-6, PS-60, PSS-60, PSE-61
and of the selective level meter SPM-60 (series H onwards)

Level blanking signal for the signal generators PS-6, PS-60, PSS-60
effective only together with plug-in ODF-601

Inputs
External standard frequency . . . . . 1 MHz
Required input voltage V_{rms} . . . . . approx. 1 V
Input impedance . . . . . approx. 1 kΩ
External carrier frequency . . . . . 24 to 42.6 MHz
for tuning of the Generator Plug-in PSE-61
of the Level Meter SPM-6 or SPM-60

1.8.7.2. Fixed Frequency Plug-in ODF-601

Number of preprogrammable fixed frequencies . . . . . Max. 26
Programming . . . . . with diodes, in 8-4-2-1 BCD code
Number of blockable frequencies . . . . . Max. 26

Programming . . . . . by straps on special blocking card

Selection of the fixed frequencies
Manual mode . . . . . by means of rotary switch

Automatic sequence,
internally switchable . . . . . single cycle or continuous sequencing
Dwell time per frequency, internally switchable. . . . . 2, 4, and 8 s

Remote control by DC voltage in steps of 0.2 V . . . . . 0 to + 5 V

LED indication of the operating mode, of the selected fixed frequency, or of the blocked frequency.

DC voltage output for X deflection of a recorder or
for synchronized control of a further ODF-601
Output voltage for 26 steps of 0.2 V . . . . . 0 to + 5 V
Internal impedance . . . . . 5 kΩ

1.8.7.3. General Specifications

Tolerable ambient temperature
Rated range of operation . . . . . + 5 to + 40 °C
Limits range for storage and transport . . . . . - 40 to + 70 °C

Power supply
Rated ranges of operation of the mains voltage . 110/117/128/220/227/238 V
- 15 % to + 10 %
Rated range of operation of the mains frequency. . . . . 45 to 66 Hz
Power consumption with plug-in . . . . . approx. 100 VA
VDE 0411 protection class I

Dimensions, w x h x d, in mm
Control oscillator OD-600 . . . . . 478 x 155 x 407
Suitable for installation in 19" rack
Plug-in ODF-601 . . . . . 125 x 66 x 330
Weight, OD-600 . . . . . approx. 13 kg
ODF-601 . . . . . approx. 1.7 kg

1.8.8. Sweep Attachment WZ-61

The technical specifications are valid for the rated ranges of operation of the ambient temperature, of the mains voltage, and of the mains frequency, after a warming up period of 30 minutes.

Sweep limits, adjustment range . . . . . 6 kHz to 18.6 MHz
Lower limit f_1 and upper limit f_2 can be set
separately by means of decade switches
Smallest setting step . . . . . 100 Hz

Error limits of f_1 and f_2: f_1 . . . . . $1\% \pm 2.5 \cdot 10^{-4} \cdot f_2/f_1$
f_2 . . . . . 1 %

for sweep limit settings between 10 kHz and 18.6 MHz
and for 10 kHz $\leqq f_1 \leqq$ 99.9 kHz and f_2/f_1 = 2 to 50 · 100 kHz/f_1
or $f_1 \geqq$ 100 kHz and f_2/f_1 = 2 to 50

Deflection

Periodic, with equal sweep times for runout and return,
sweep time switchable . . . . . 20 ms, 50 ms, 100 ms, ... 5 s
Single sweep, with start at f_1 or f_2, sweep time . . . . . .50 s
Manual, with 10 turn potentiometer, between . . . . . f_1 and f_2
Without sweep, fixed . . . . . .f_1 or f_2

X output

Output voltage V_{pp}, proportional to the swept frequency,
dependent on f_1 and f_2 . . . . . 0.5 V to 5 V
Output impedance . . . . . 5 kΩ

General Specifications

Tolerable ambient temperature
Rated range of operation . . . . . .+ 5 to + 40 °C
Limits range for storage and transport . . . . . - 40 to + 70 °C

Power supplies
Nominal operating ranges of the mains voltage . 110/117/128/220/227/238 V
- 15 % to + 10 %
Nominal operating range of the mains frequency . . . . . 45 to 66 Hz
Power consumption . . . . . approx. 48 VA
VDE 0411 protection class I
Dimensions, w x h x d, in mm . . . . . 478 x 110 x 407
Suitable for installation in 19" rack
Weight . . . . . .approx. 10 kg

1.9. Ordering information

Selective Level Meter SPM-60:	BN 611/0
with frequency locking device and 24 Hz bandwidth	BN 611/5
with additional balanced input	BN 611/6
with balanced input, frequency locking device and 24 Hz bandwidth	BN 611/8
Measuring accessories at extra cost	
Passive Test Probe TK-9	BN 265
Active Test Probe TK-12 with Power Supply TKN-12	BN 574
	and BN 623
Inverter	BN 678
Return Loss Measuring attachment RFZ-5	BN 394
Return Loss Measuring Attachment RFZ-12	BN 810/01.00
Signal Balance Ratio Measuring Attachment SDZ-12	BN 811/01.00
Decade Control Oscillator OD-600	BN 614
Carrier frequency board 24 to 42.6 MHz required for PS-60, PSS-60, PSE-61, SPM-60	BN 614/21
Remote Control board	BN 614/22
Continuous frequency tuning[1]	BN 614/23
Fixed Frequency Plug-in ODF-601, including programming and frequency blocking cards for 26 frequencies	BN 651
Sweep Adapter WZ-6[2]	BN 408
Sweep Adapter WZ-61	BN 689
Generator Plug-in PSE-61[2]	BN 690
Transport cover for WZ-61	DE 1
Transport cover for WZ-6, OD-600	DE 2
Transport cover for SPM-60	DE 3
Transport case for 1 each SDZ-12 and RFZ-12	BN 626/8

1) Conversion in the factory or by service centers

2) See appropriate data sheets for specifications

Anmerkungen zu den Schaltteil-Listen in EDV-Ausdruck Notes for EDV-Parts Lists Remarques sur les listes des composants

Erklärung der wichtigsten Abkürzungen und der Darstellung der Daten

Benennung	Bezeichnung 1	Bezeichnung 2	
Darstellung in diesem Bereich entspricht genau dem EDV-Ausdruck			Erläuterungen in deutsch, englisch und französisch soweit erforderlich
R-KOHLE	100 5% 0309		Kohleschicht-Widerstand 100 Ω 5% D x L = 3 x 9 mm Carbon Film Resistor Résistance à couche de carbone
R-METALL	2,77 K 0,1% 0207	TK 50	Metall-Schichtwiderstand 2,77 kΩ 0,1% TK 50 D x L = 2 x 7 mm Metal Film Resistor Résistance à couche métal
R-DRAHT	47 10% 2 W	WM 50 SKA 2	Drahtwiderstand 47 Ω 10% 2 Watt Mat.: WM 50, Typ SKA-2 Wirewound Resistor Résistance bobinée
R-TRIMM-CERMET	470 20% 0,5 W 1	150	Trimm-Widerstand Cermet 470 Ω 20% 0,5 W 1 Umdrehg. TK 150 PPM Adjustment Potentiometer Cermet 1-Turn Potentiomètre d'ajustment Cermet 1 tour
R-TRIM DRAHT SPINDEL	5 K 5% 0,7 W 22	70	Spindel-Trimmer Draht 5 kΩ 5% 0,7 Watt 22 Umdrehungen TK 70 Rectangular Wirewound adjustment Potentiometer 22 Turns Potentiomètre d'ajustment bobiné 22 tours
R-TRIM DRAHT SQUARE	20 K 5% 0,7 W 25	70	Square-Trimmer Draht 20 kΩ 5% 0,7 Watt 25 Umdrehungen TK 70 PPM Square Wirewound adjustment Potentiometer 25 Turns Potentiomètre d'ajustment bobiné Square 25 tours
R-VAR KOHLE	100 10/20 0,2 W LIN	260	Kohleschicht-Pot. 100 Ω - 10/+ 20 % 0,2 W linear, Drehwinkel 260° Carbonfilm Potentiometer Potentiomètre à couche de carbone
R-VAR DRAHT	5 K 3% 2 WLIN	3600 0,25%	Drahtpotentiometer 5 kΩ 3% 2 W Linear 3600° = 10-Gang Linearitätstoleranz 0,25% Wirewound Potentiometer 10-Turns Potentiomètre bobiné 10 tours
ELKO-AL	470 U 10/50 70 V		Aluminium-Elko 470 µF - 10/+50% 70 V, gepolt Aluminium Electroytic Capacitor, polarized Condensateur électrolytique à l'aluminium polarisé
ELKO-AL UNGEPOLT	100 U 40 V	EU 100/40	Aluminium-Elko ungepolt (bipolar) 100 µF 40 V Typ EU 100/40 Aluminium Electrolytic Capacitor, unpolarized Condensateur électrolytique à l'aluminium non polarisé
ELKO-TA SINT FEST	6,8 U 20% 6,3 V		Tantal-Elko Sinteranode, fester Elektrolyt 6,8 µF 20% 6,3 V Tantalum Electrolytic Capacitor, Sintered Anode dry Condensateur au tantale à électrolyte solide
C-KERAMIK EDPU	120 P 2% 63 V	N 150 1 B	Keramik-Kondensator 120 pF 2% 63 V Keramik: N 150 Typ 1 B EDPU = Kennzeichnung nach DIN 41930 Ceramic Capacitor Condensateur céramique
C-KERAMIK RDLL	88,7 P 1% 25 VEF	N 075 1 B KZK4	Keramik-Kondensator kurzzeitkonstant (10-4) 88,7 pF 1% 25 V_{eff} Material N 075 Typ 1 B Ceramic Capacitor Short-Term-Stability Condensateur céramique de stabilité de lourte durée
C-GLIMMER	487 P 0,5% 500 V	BF 48.10	Glimmer-Kondensator 487 pF 0,5% 500 V Bauform 48.10 Mica Capacitor Type 48.10 Condensateur au mica argenté
C-GLIMMER KNOPF	3900 P 5% 100 V	BF 49.25-3	Glimmer-Knopf-Kondensator 3,9 nF 5% 100 V 49.25-3 Mica Button Capacitor Condensateur bouton au mica argenté
C-KF KS	316 P 0,5% 63 V	KSM	Kunststoff-Folienkondensator Styroflex 316 pF 0,5 % 3 V Polystyrene Capacitor Condensateur polystyrène
C-KF MKT	0,068 U 10% 100 V		Metallisierter Polyester Kondensator 68 nF 10% 100 V Metallized Polyester Capacitor Condensateur polyester métallisé
C-DREH	9,0-25,0 P 1-Fachc-LIN 2222 805 90123		Drehkondensator 9-25 pF 1-fach C-Linear Typ... Variable Capacitor, Single-Section, SLC, Type... Condensateur variable, Variation linéaire en capacité
C-DREH SCHMETTERLING			Schmetterling-Kondensator Butterfly variable Capacitor Condensateur papillon

C-TRIM KER SCHEIBE	10,0-60, 0P N 1500	xxx...	Keramik Scheibentrimmer 10-60 pF Material N 1500 0,5 Umdrehungen Typ xxx ... Variable Ceramic Disc Capacitor Condensateur ajustable disque céramique
C-TRIM GLAS ROHR	0,5- 3, 0P 100PPM 12	xxx...	Glasrohrtrimmer 0,6 - 3 pF TK 100 PPM 12 Umdrehungen Typ xxx... Glass Piston Trimmer Capacitor ... 12 Turns Condensateur ajustable
C-TRIM LUFT	1,75-15, SP 45 PPM 0,5	xxx...	Lufttrimmer (Platten) 1,275 - 15,5 pF RK 45 PPM 0,5 Umdrehg. Typ xxx... Air variable Capacitor Condensateur ajustable
C-PAPIER ENTSTOER			Funkentstörkondensator R.F.-Interference-Suppression Capacitor Condensateur d' antiparasitage
L-FUNKENTSTOER			Funkentstördossel Microwaves Interference Suppression Choke Self d' antiparasitage pour ondes ultra-courtes
L-FEST	15 u 10%		Festinduktivität 15 µH 10% R.F. Molded Choke Inductance
C-KF KC	13300 P 1% 63 V	KC 1853	Polycarbonat-Kondensator 13300 pF 1% 63 V Typ KC 1853 Polycarbonate-Capacitor Condensateur à film polycarbonate à armatures
C-KF MKC	220000 P 20% 250 V	MKC 1858	Metallisierter Polycarbonat-Kondensator 220000 pF 20% 250 V Typ MKC 1858 Metallized Polycarbonate Capacitor Condensateur à film polycarbonate métallisé
C-KF KT	0,015U % 100 V	KT 1801	Polyester-Kondensator 0,015 µF 5% 100 V Typ KT 1801 Polyester Capacitor Condensateur à film polyester à armatures
C-KF MKU	10 U 10% 63 V	B 32110	Cellulose-Acetat Kondensator 10 µF 10% 63 V Typ B 32110
C-KF KP	183000 P 2% 160 V		Polypropylen-Kondensator 183000 PF 2% 160 V Polypropylene Capacitor Condensateur à film polypropylène à armatures
S-DREH	Werksinterne Daten Ersatz per Sach-Nr. bestellen		Drehschalter Rotary switch Commutateur rotatif
S-KIPP	"		Kippschalter Toggle switch Interrupteur à touche basculante
S-SCHIEBE	"		Schiebeschalter Slide switch Interrupteur à glissière
S-TASTE	"		Tastenschalter Push-button switch Commutateur à touches
S-SCHNAPP	"		Schnappschalter Micro switch Interrupteur à déclic
S-KODIER	"		Kodierschalter Thumb-Wheel switch Roue codeuse
RELAIS			
IC-.. TRANS...	"	Mos	mit " Mos" sind alle Halbleiterbauelemente gekennzeichnet, die durch elektrostatische Aufladung gefährdet sind. Die hierfür gültigen Verarbeitungsvorschriften sind unbedingt einzuhalten. All semiconductors subject to damage caused by electrostatic discharge are identified with the letters "Mos". The existing regulations applied to handling these devices are to be unconditionally complied with. Tous les semi-conducteurs pouvant être détériorés par une charge électrostatique sont identifiés avec "MOS". Les consignes concernants la manipulation de ces éléments sont absolument à respecter.

Important Safety Instructions

A.C. power line voltage

The operating voltage of the instrument should be the same as the a.c. line voltage, so check whether or not the two voltages are equal.

Safety Class

This instrument is categorized as Safety Class I according to VDE 0411 or IEC Publ. 348. The power cord delivered with the equipment has a protective ground conductor. The a.c. power plug must be plugged into an a.c. power receptacle that has a third wire to ground, except in rooms that are particularly certified otherwise. Any disconnection of the protective ground conductor either inside or outside of the instrument is not permitted.

Connection to measuring circuits presenting hazards to personnel

Before the connection is made to a hazardous circuit, a protective ground connection, for protection against the measurement circuit, ought to be connected to the enclosure. In case the protective ground conductor of the a.c. power line can also assume this protective function, the a.c. power connection should be established first of all. If the measuring circuit has an inherent protective ground conductor, then this conductor must be connected to the enclosure before a connection is made to the measuring circuit.

Defects and Exceptional Conditions

When it can be assumed that safe operation is no longer possible, the equipment should be taken out of service and inadvertent operation should be prevented.
This occurs when

- the equipment shows external signs of damage
- the equipment no longer operates
- after being overstressed in any way (e.g. storage, transport) so that the tolerable limits are exceeded.

Fuses

Only specified fuses are permitted for use.

Opening the Instrument

After the covers have been removed or when components are removed with tools, certain components that operate with applied voltage could be exposed. And also connection points might be carrying a voltage.
Therefore, before the instrument is opened for inspection, all voltage sources should be disconnected.
But sometimes calibration, maintenance or repairs require that the instrument be open and operating with applied voltage. So only experienced craftspersons who understand the dangers associated with working on instruments that have exposed voltage points should undertake the job.
Capacitors can retain a voltage charge even after the instrument has been disconnected from voltage sources. Thus, the circuit diagrams should be observed.

Repairs, Replacement of Components

Repairs must be done according to correct technical practice. With that, particular attention must be paid to the characteristics of construction. None of the safety precautions should be changed, especially for leakage paths and air gaps, and separation by insulation must not be reduced.
Only original replacement parts ought to be used. Other replacement parts are only permitted if the safety and protection against human injury are not degraded through the use of non-original components.

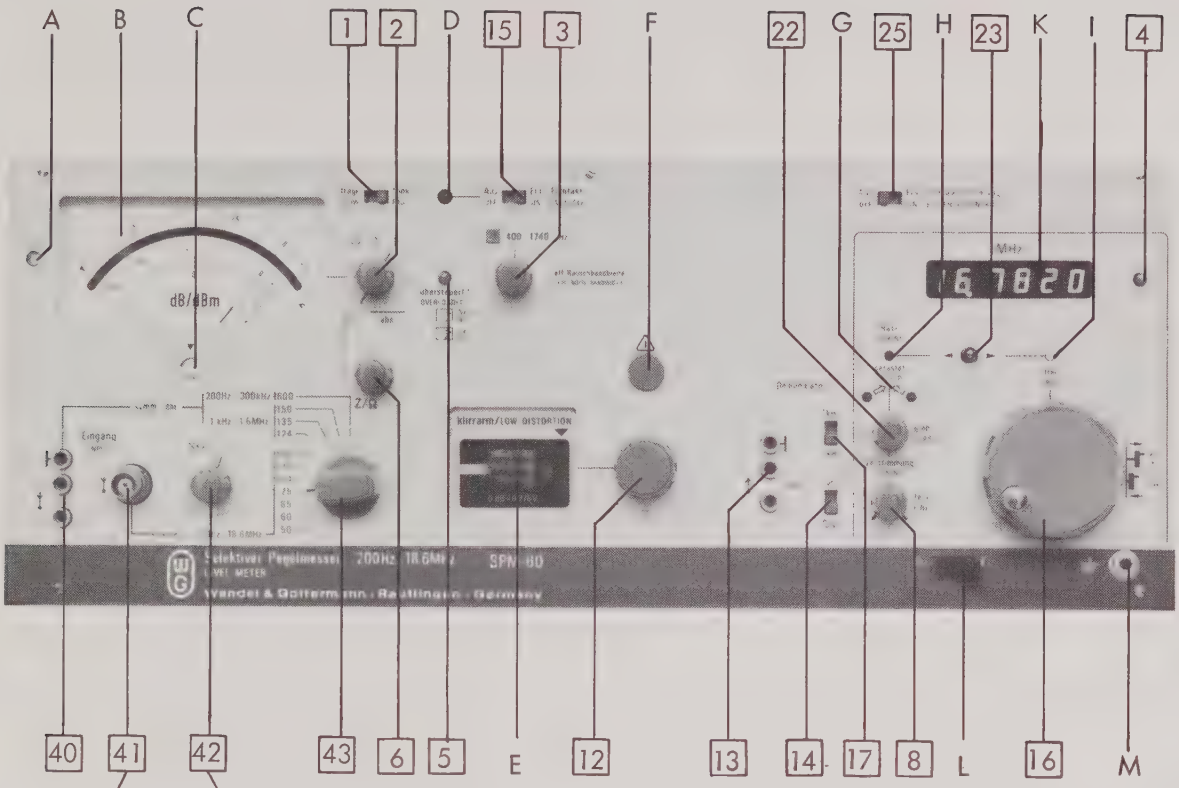
Safety Testing after Repair and Maintenance

Testing of the protective ground conductor in the power cord for the instrument:

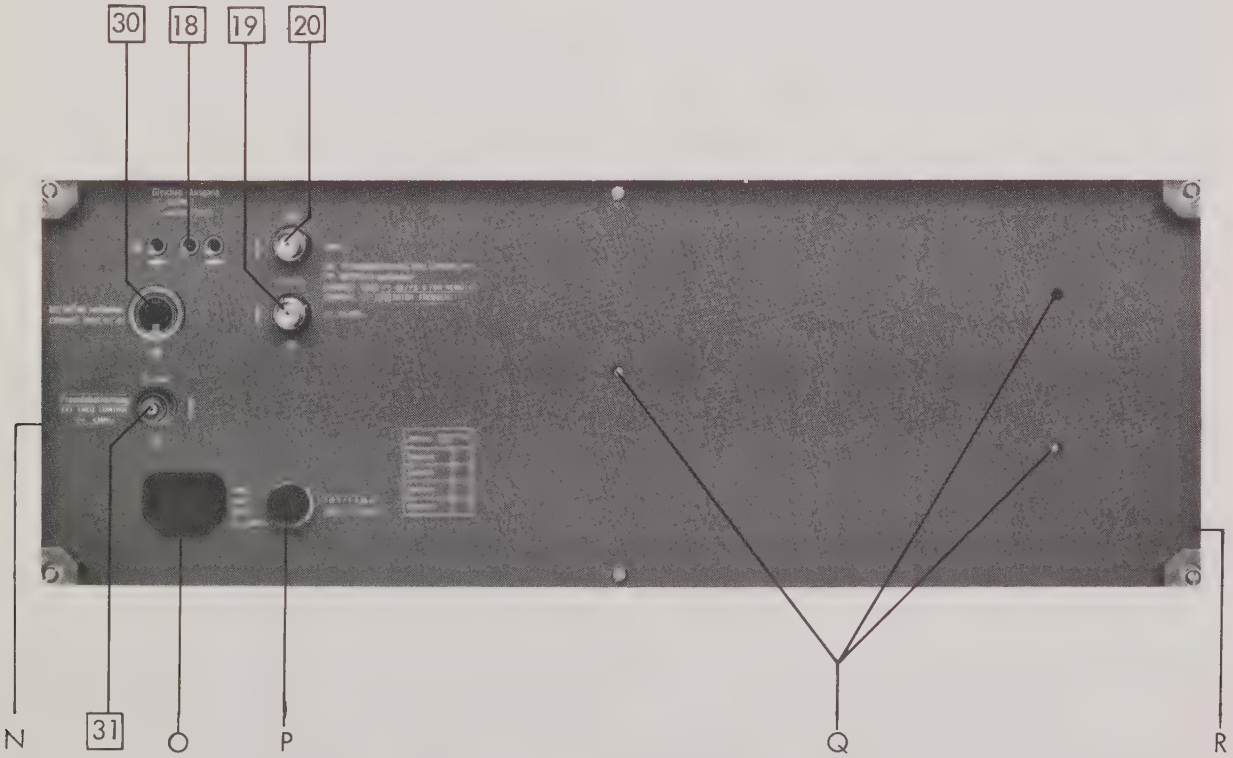
The resistance of the protective ground conductor shall be measured. It should be $<0.5\,\Omega$. The power cord should be bent and kinked during the measurement so as to reveal any intermittent connection. This gives evidence of a defective power cord.

Testing the insulation of the a.c. power circuit:

The insulation resistance is measured at 500 V between the a.c. power connection and the protective ground conductor connection. For this measurement, the instrument's power switch should be ON.
The insulation resistance ought to be $>2\,M\Omega$.



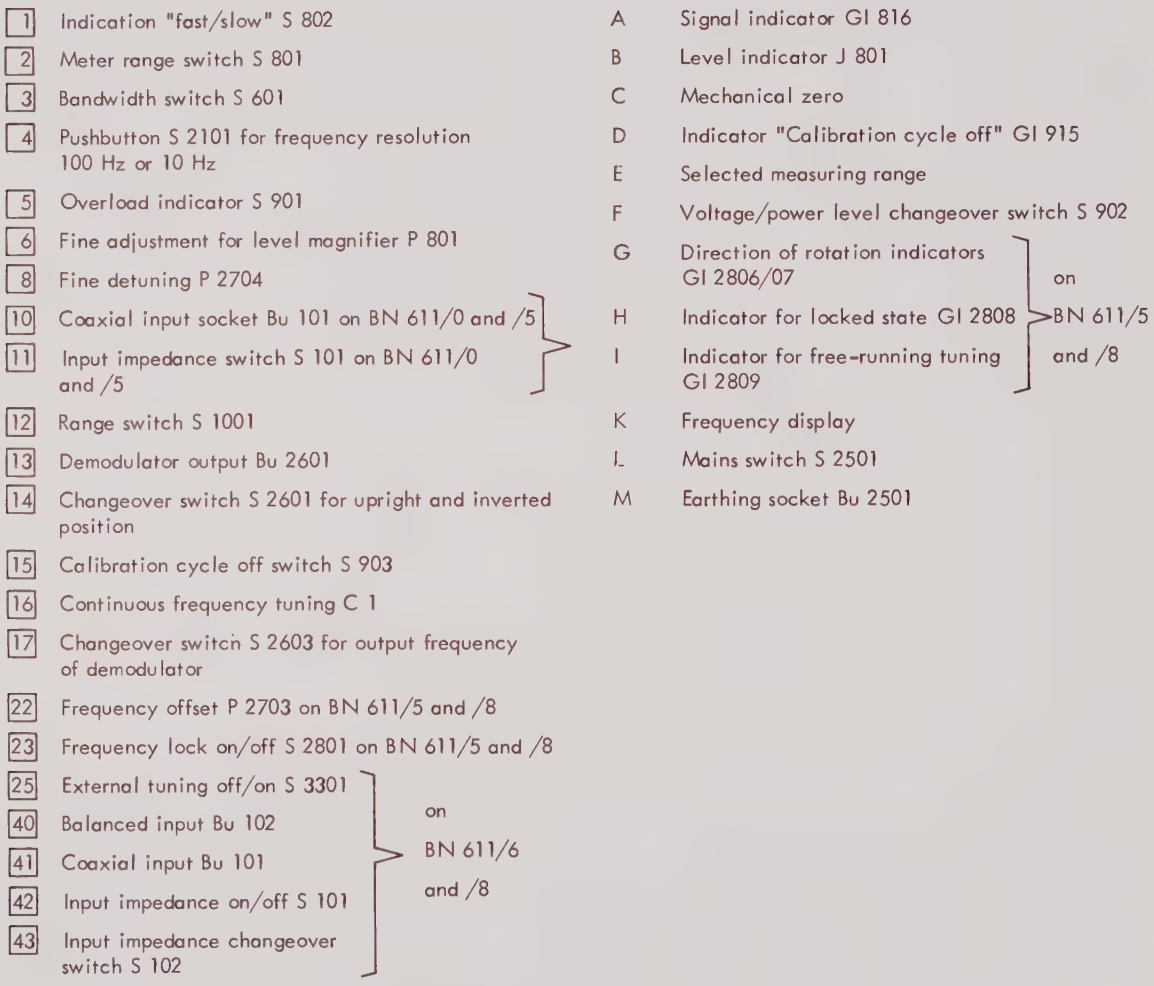
(or 10 and 11 at BN 611/0 and /5)



CONTROLS AND CONNECTORS OF THE SPM-60

The numbers within boxes coincide with those printed on the front and rear sides of the equipment.

Figure 2-1 Front view



- [1] Indication "fast/slow" S 802
- [2] Meter range switch S 801
- [3] Bandwidth switch S 601
- [4] Pushbutton S 2101 for frequency resolution 100 Hz or 10 Hz
- [5] Overload indicator S 901
- [6] Fine adjustment for level magnifier P 801
- [8] Fine detuning P 2704
- [10] Coaxial input socket Bu 101 on BN 611/0 and /5
- [11] Input impedance switch S 101 on BN 611/0 and /5
- [12] Range switch S 1001
- [13] Demodulator output Bu 2601
- [14] Changeover switch S 2601 for upright and inverted position
- [15] Calibration cycle off switch S 903
- [16] Continuous frequency tuning C 1
- [17] Changeover switch S 2603 for output frequency of demodulator
- [22] Frequency offset P 2703 on BN 611/5 and /8
- [23] Frequency lock on/off S 2801 on BN 611/5 and /8
- [25] External tuning off/on S 3301
- [40] Balanced input Bu 102
- [41] Coaxial input Bu 101
- [42] Input impedance on/off S 101
- [43] Input impedance changeover switch S 102

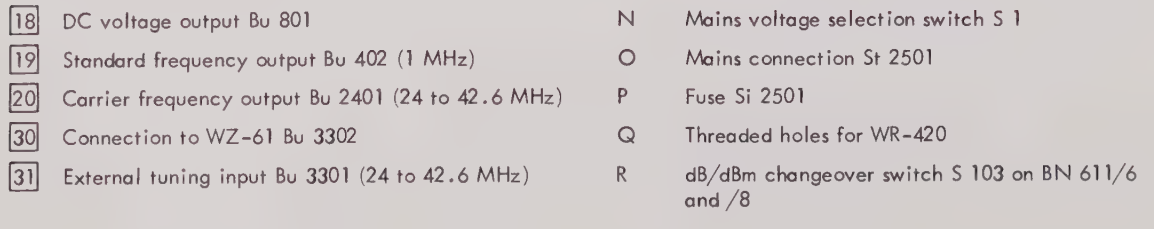
(25, 40, 41, 42, 43: on BN 611/6 and /8)

- A Signal indicator GI 816
- B Level indicator J 801
- C Mechanical zero
- D Indicator "Calibration cycle off" GI 915
- E Selected measuring range
- F Voltage/power level changeover switch S 902
- G Direction of rotation indicators GI 2806/07
- H Indicator for locked state GI 2808
- I Indicator for free-running tuning GI 2809

(G, H, I: on BN 611/5 and /8)

- K Frequency display
- L Mains switch S 2501
- M Earthing socket Bu 2501

Figure 2-2 Rear view



- [18] DC voltage output Bu 801
- [19] Standard frequency output Bu 402 (1 MHz)
- [20] Carrier frequency output Bu 2401 (24 to 42.6 MHz)
- [30] Connection to WZ-61 Bu 3302
- [31] External tuning input Bu 3301 (24 to 42.6 MHz)
- N Mains voltage selection switch S 1
- O Mains connection St 2501
- P Fuse Si 2501
- Q Threaded holes for WR-420
- R dB/dBm changeover switch S 103 on BN 611/6 and /8

2. OPERATION

2.1. Setting up the unit

The Selected Level Meter SPM-60 is designed for both stationary and mobile operation. The tolerable ambient temperatures are specified in Section 1.7.

2.1.1. Operating controls

All controls, indicators, and the input sockets for the measured signal are arranged clearly on the front panel.

The mains connection, control outputs, and the DC voltage output are located on the rear of the unit.

The positions of all controls are shown in Figures 2-1 and 2-2.

2.2. Connecting and commissioning the unit

2.2.1. Mechanical zero

Before switching on the level meter, check the mechanical zero "▼" of the meter and correct it if necessary.

2.2.2. Mains operation

When it leaves the factory, the SPM-60 is set to a mains voltage of 220 V. If a different voltage range is required, this is easily selected with the mains voltage selection switch. The selected voltage is displayed in the window on the right sidewall of the unit.

For the mains voltage range 200/235 V, the fuse value is 0.125 A, slow-blow. If the unit is switched to the 110/127 V range, a 0.25 A, slow-blow, fuse must be fitted. The unit is classified in protection class I in accordance with VDE 0411, i. e. the chassis and the earthing socket are connected to the protective conductor.

2.2.3. Mobile operation

For mobile operation, the SPM-60 is operated from an external battery via the Inverter WR-420. The Inverter can be switched to nominal battery voltages of 12 V, 24 V, 36 V, and 48/60 V.

Two output voltage ranges are available: 220 V/400 Hz or 117 V/400 Hz. The output voltage is sinusoidal and the output power is 20 VA. The complete Level Measuring Setup PS-60/SPM-60 requires one WR-420 Inverter for each unit.

2.3. Measuring

The voltage to be measured is connected to the input of the level meter by means of suitable cables. The input impedance remains linear even if the unit is switched off, thus avoiding unwanted effects on the object being measured.

If the input signal is missing, the pointer of the meter remains in the extreme left position.

2.3.1. Inputs, input impedances, and frequency ranges

The versions BN 611/0 and /5 are equipped with a coaxial input [10] for the frequency range 200 Hz or 2 kHz to 18.6 MHz. The input impedance can be switched with switch [11] to Z_{in} = 75 Ω or Z_{in} = 10 kΩ, according to the technical requirements.

The versions BN 611/6 and /8 have an additional balanced input [40] for frequencies from 200 Hz or 2 kHz to 1.6 MHz with a switchable input impedance (switch [43]) of 124, 135 and 150 Ω or high impedance. With an input impedance of 600 Ω, balanced measurements are possible between 200 Hz or 2 kHz and 300 kHz. The coaxial input in these versions can be switched between input impedances of 50, 60, 65, 75, 124, 135, 150 Ω with switch [43] or to high impedance (switch [42]).

2.3.2. Setting-in the receive frequency

2.3.2.1. Continuous frequency tuning

The required receive frequency can be tuned continuously in a single range with the aid of the crank [16] .

For coarse tuning (= drive knob [16] depressed), the frequency display is 5 digits (resolution 1 kHz).

For fine tuning (= drive knob [16] pulled out), i. e. with the fine drive additionally connected (drive ratio 20 : 1), the display has 6 digits (resolution 100 Hz).

In addition, particularly precise frequency tuning can be achieved with potentiometer [8] "Frequency fine". The fine detuning range is approx. 200 Hz at low frequencies and approx. 1.5 kHz at high frequencies. This fine tuning should be carried out with a resolution of 10 Hz in order to provide the special accuracy which is advantageous when measuring pilot levels. To do this, pushbutton [4] alongside the display[1] is depressed with the drive knob [16] pulled out, this resulting in the decimal point being shifted one position to the left and the first digit disappearing from the display.

If the above-mentioned pushbutton [4] is depressed with a 5-digit display (coarse tuning), the display also appears with 6 digits (resolution 100 Hz).

2.3.2.2. Crystal-locked frequency tuning

The versions BN 611/5 and /8 are equipped with a crystal-controlled frequency locking device. The meter is first tuned to the required frequency with the frequency lock switched off - switch [23] in position "free", and display active - with tuning knob [16], as described in Section 2.3.2.1.

When the frequency lock switch [23] is moved to the position "lock", one of the two red lamps with arrow symbols lights. The illuminated lamp indicates the direction in which the tuning knob [22] must be turned. As soon as the red lamp goes out, the selected frequency, which is displayed on the counter, is crystal-locked. The locked state is indicated by the green lamp with the designation "locked".

The required frequency can now be set to the final value with potentiometer [22]. With the aid of this knob, the frequency can be tuned within a range of approx. 7 kHz.

An additional fine tuning of approx. ± 50 Hz is possible with knob [8], this being particularly advantageous for measurements with the narrow 24 Hz filter (BN 611/5 and /8).

The potentiometers [8] and [22] are active only in the locked state, and the drive knob [16] should not be operated in this case.

---

1) If the frequency is tuned below zero, the counter indicates 99.9999 MHz or less. This display is of course invalid (frequency limit 18.7 MHz).

If the crank [16] is inadvertently moved or if the unit is switched off and on again, the frequency may leave the locked state (the "locked" lamp no longer lights). In order to lock the frequency again in this case, turn the switch [23] again to the "lock" position. The locking operation can now be repeated.

2.3.2.3. Decadic frequency tuning with the OD-600

The Control Oscillator OD-600 permits decadic tuning of the receive frequency with minimum steps of 1 Hz. The unit, equipped with the carrier frequency card BN 614/21. supplies the carrier frequency in the range 24 to 42.6 MHz. This is connected to the external tuning input [31] of the SPM-60 with a short coaxial 75 Ω cable from the rear of the oscillator.

A connection is required between the standard frequency output [19] on the SPM-60 and the 1 MHz input [15] on the OD-600 for synchronization of the two units.

When the external tuning switch [25] is set to "On", the OD-600 carries out tuning of the level meter. The receive frequency continues to be displayed on the counter of the SPM-60.

All equipment connections and the settings of the control oscillator and Fixed Frequency Plug-in ODF-601 are described in the description and operating instructions for the OD-600. Applications examples for the level meter with Control Oscillator OD-600/ODF-601 are described in Section 3.3. of the measuring instructions.

2.3.2.4. Remote control of PS-60, PSS-60 and PS-6

If the generator and receiver are operated in the same location, the frequency of the above mentioned generators can also be synchronously tuned by means of a cable connection.

The necessary cable connection is shown in the following illustration:

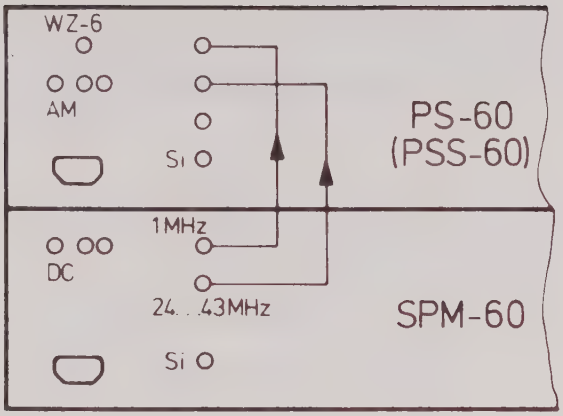


Fig. 2-3

2.3.3. Level reading

2.3.3.1. Measuring ranges encompassed analog meter

The analog meter B has the following three scale ranges:

unexpanded scale :	- 22 dB to + 1 dB
expanded scale :	- 2.2 dB to + 0.3 dB
expanded scale (level magnifier) :	- 0.5 dB to + 0.5 dB

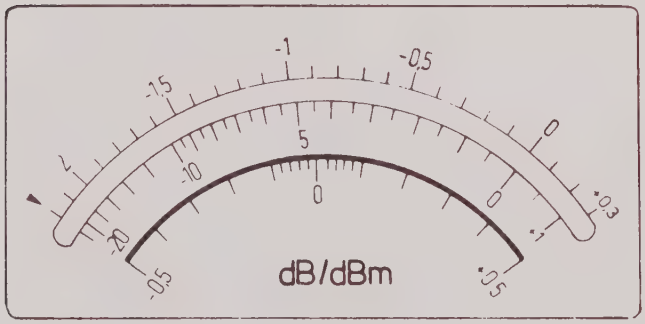


Fig. 2-4

2.3.3.2. Absolute level measurements

The indicating ranges were selected to be 20 dB, 2 dB and ± 0.5 dB, this came about because of the various measurement tasks arising in practice and can be expressed as:

1) Measurement of a signal whose amplitude is almost the sum of the signals present at the input to the Level Meter.

Under this category, most of the usual level measurements occur, especially the measurements which are to be made with the highest possible accuracy. For this

reason, the analog meter B should be used with the expanded scale of 2 dB. Indicating range switch [2] permits the choice of range where reading is most easily done.

When searching for unknown signals or for scanning type measurements, the measurement scale of 20 dB on analog meter B can also be used.

The measured level results from the sum of the value set-in at the measurement range switch [12] plus the reading of the scale value taking into account the setting of the scale range switch.

2) Measurement of a signal whose amplitude is essentially smaller than the sum of signals present at the input to the Level Meter. This is mainly the case with distortion ratio measurements, determining intermodulation products, noise voltage measurements on an in-service CF system and similar cases.

Measurements of that type are made with the 20 dB scale of analog meter B.

Therefore, it is necessary to observe that the input stages are presented with signal-drive from both the signal to be measured as well as the summed signal of higher magnitude. So with the worst case, measurement errors can occur. For this reason, the described measurements preferably should be made in the indicator field E "white", which identifies low distortion level measuring ranges (- 30, - 50, - 70, - 90, - 100, - 110 dB or - 20, - 40, - 60, - 80, - 90, - 100 dBm).

Also for measuring very low levels (set-in measuring range - 100 dBm or - 110 dB) it is worthwhile to change to the 20 dB scale (unexpanded range).

2.3.3.3. Relative level measurements

For a series of measurements e. g. determining variations with frequency, the absolute values are not as important as the deviations from a previously provided reference value.

If the meter scale change-over switch [2] is used so that after a measurement is made in the 2 dB range the position "± 0.5 dB" is selected, then the use of potentiometer [6] permits any chosen meter reading in the 2 dB range to be shifted to the centre of the scale, i. e. 0 dB reading. Thereby, the smallest deviations to 0.01 dB of relative level can be read with increased accuracy from the scale divisions of 0.02 dB on each side of the 0 dB scale mark.

However, it is very important to observe that, in the ± 0.5 dB scale range, the reading is no longer absolutely calibrated.

2.3.3.4. Meter reading change-over

If the meter reading is rapidly fluctuating, then the meters can be switched from fast to slow with switch [1] . This possibility exists for all three positions of the range change switch [2] .

2.3.3.5. Overload check

Measurement errors caused by overload (over-driven signals) can be easily recognized after the OVERLOAD push button [5] is depressed. If the pointer of the analog meter remains steady, then the measurement is correct. If, however, the pointer oscillates at a 1 Hz rate then the measured result indication is not valid. The signal drive in the Level Meter must be reduced with the range switch [12] which reduces the sensitivity until the OVERLOAD check indicates that the measurement does not suffer from an overloaded condition. Thereby, switch [1] remains in position "FAST".

2.3.3.6. Voltage level - power level calibration ⚠

The level meter can be switched from voltage level calibration, 0 dB ≙ 0.775 V (= 1 mW into 600 Ω) to power level, 0 dBm ≙ 1 mW into Z, with the aid of switch F. Z is the selected input impedance (see also Section 2.3.1.). The reference value dB/dBm is displayed in the window.

In addition to switching with switch F, the units with balanced input (BN 611/6 and /8) also require a correction of the meter indication in the position "600 Ω" of the input impedance changeover switch [43] . To do this, remove the left side cover or the baseplate and move the slide switch R alongside the input amplifier (2) to the required position (dB-dBm). The position of the slide switch should be checked each time the calibration is switched in order to avoid incorrect measurements at 600 Ω.

2.3.3.7. Signal indicator

The rapid signal indicator A is used as a tuning aid for finding unknown received signals. As soon as a voltage whose level would result in a visible indication on

the meter is present at the input, the signal indicator lamp A lights because the meter indication is too slow to indicate the signal when the frequency is tuned rapidly.

2.3.3.8. Bandwidth

The effective noise bandwidth of the selective level meter SPM-60 can be switched between 1.74 kHz and 400 Hz with switch [3]. The larger bandwidth is used mainly for finding unknown receive frequencies for noise measurements and for work with the demodulation device; but the smaller bandwidth is advantageously used, for example, for analyzing adjacent signals and in the presence of noise interference. The equipment versions BN 611/5 and /8 have a frequency locking circuit specially provided for measurements which require high long-term stability of the tuned frequencies, for example continuous monitoring applications. These versions also have a pilot filter with an effective noise bandwidth of 24 Hz in order to permit, for example, measurement of group and super group pilot signals under operating conditions and with narrow bandwidth. The lower limit frequency of units with the 24 Hz filter is reduced from 2 kHz to 200 Hz.

2.3.3.9. Calibration cycle deactivation

In order to simplify tuning for narrow band level measurements, the calibration cycle can be switched off with the slide switch [15].

The state "Calibration cycle off" is indicated by a red lamp D. If there is no input signal, or if the input signal is too low, the unit automatically switches off the calibration cycle and is then continuously in the state "Measurement".

2.3.3.10. Demodulator

The built-in demodulator permits demodulation of amplitude-modulated signals, which are then available at output [13].

The demodulation mode can be set with changeover switch [14] to

demodulation of the upper sideband (normal position)

or

demodulation of the lower sideband (inverted position)

For correct demodulation, the receive frequency must be detuned by 1.35 kHz with respect to the carrier, namely by + 1.35 kHz for the normal position and by - 1.35 kHz for the inverted position.

The instrument display and the calibration cycle remain active when the demodulator output is used. If, however, the calibration signal causes interference, the calibration cycle can be switched off (see Section 2.3.3.9.).

For interruption or phase jitter measurements, the demodulator output can also be switched with slide switch [17] from 1 kHz to 2 kHz, the 1 kHz frequency being used mainly for phase jitter measurements together with a data circuit test set, for example W & G DLM-1. It should be noted that the frequency lock must be switched on and the calibration cycle switched off for this purpose, and that the bandwidth 1.74 kHz and the "low noise" measuring ranges (see details in Section 1.6.) must be selected. The meter should wherever possible have full scale deflection for the input level in order to achieve a high signal-to-noise ratio. A slightly overdriven indication has no negative effects on the results of measurement.

In addition, care must be taken that the level meter is mounted such that it is not affected by vibrations because shocks or vibrations can cause phase-shifts during jitter measurements. These phase-shifts are created in the tuning capacitor and cannot be completely compensated by the phase control principle used in the equipment.

The 2 kHz frequency is used mainly for interruption measurements in accordance with CCITT. In this case, the low frequency signal available at the demodulator output, when an input signal is connected, is passed to an interruption counter. As the measurement is normally carried out for long periods, the tuning frequency of the SPM-60 must be locked.

2.3.3.11. DC voltage output

The output [13] provides a DC voltage which is proportional to the meter indication. This voltage is 5 V for full-scale deflection of the meter with an output impedance of 5 kΩ. As the gain of the unit is extremely constant, due to the automatic calibration facility, the output is particularly suitable for continuous monitoring applications with recorders, oscilloscopes and similar devices.

The output socket [13] is connected such that the positive voltage is present on pin a in the center, while pins b and c are connected to earth.

2.4. Measuring accessories

2.4.1. Test Probe TK-9

The TK-9 is a passive test probe with an insertion loss of 20 dB. Th input capacitance of the SPM-60 is reduced to approximately 15 pF by the Test Probe. The input impedance is approximately 5 kΩ. This probe makes it possible to extract measured voltages at points which are difficult to reach without loading the unit being tested by cable capacitances. The test probe should be connected to the coaxial input [10] or [41] with the SPM-60 set to the position $Z_{in} = 75\ \Omega$.

2.4.2. Test Probe TK-12

The Active Test Probe TK-12 has a gain of 1. It is characterized by a very low frequency response error, low noise, and high signal balance ratio and common mode rejection. The power supply for the Probe is provided by the power supply unit TKN-12, which also provides matching to the coaxial input socket [10] or [41] of the SPM-60. The switch [11] or [42], respectively, must be in the position ($Z_{in} = 10\ k\Omega$).

For coaxial measurements in the frequency range up to 18.6 MHz, the universal Versacon ® 9 adapter system (see also Section 5.4.) permits the use of all commercially available plug systems. In addition, there is a test prod with earth clamp for measurement within modules. The screw-on plug S 804 is optionally available for balanced measurements in the frequency range up to 2 MHz.

The signal Generator PS-60, for example, can be used as a calibration source for calibrating the Test Probe. Care must be taken that the Signal Generator output is terminated with the selected Z value in order to avoid frequency response errors.

For correct demodulation, the receive frequency must be detuned by 1.35 kHz with respect to the carrier, namely by + 1.35 kHz for the normal position and by - 1.35 kHz for the inverted position.

The instrument display and the calibration cycle remain active when the demodulator output is used. If, however, the calibration signal causes interference, the calibration cycle can be switched off (see Section 2.3.3.9.).

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The signal Generator PS-60, for example, can be used as a calibration source for calibrating the Test Probe. Care must be taken that the Signal Generator output is terminated with the selected Z value in order to avoid frequency response errors.

3. TECHNICAL INSTRUCTIONS

3.1. Measurement of very high impedance

When level measurements are made on devices which can be represented by two port networks, the impedance inherent to the ground loop between Generator and Level Meter is a very complicated influence quantity. An ideal case is where the chasses are connected with zero impedance between the signal generator and the unit under test and between it and the signal receiver. Another ideal case is where the isolation impedance is infinitely high between the Rex-Gen chassis-ground connections. For these two cases, the measurement error, even at any high attenuation, is dependent only on the order of magnitude of the accuracy of Generator and Receiver or on the sensitivity of the latter. Fig. 3-1 illustrates these relationships.

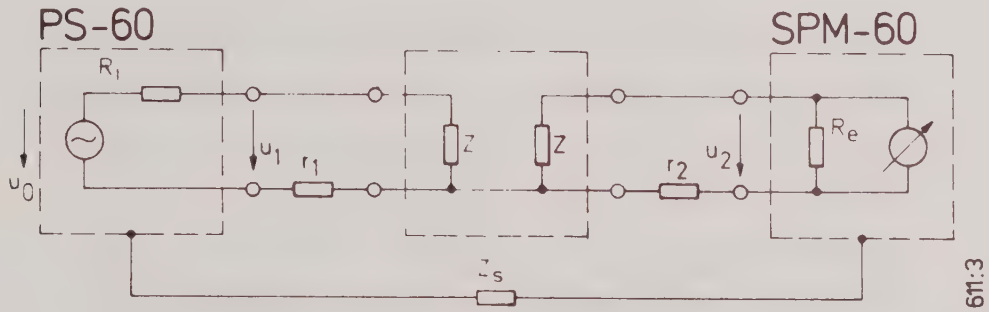

Fig. 3-1

A two port network of infinitely high attenuation serves for the test specimen. Z_s is the isolation impedance, r_1 and r_2 are the unavoidable resistances of the ground return conductors [1] which, as Z_s, could be complex impedances. The Generator current return flow (through r_1) causes a voltage drop across r_1. This voltage drop also represents a potential difference between the chassis of the Generator and the chassis of the Receiver.

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1) In the literature, r_1 and r_2, are termed "surface transfer resistance" for coaxial cables, connectors, and simular components, and are defined as follows:
Surface transfer resistance =
Voltage drop across the outer skin of the outer conductor / Current through the inner skin of the outer conductor

or Voltage drop across the inner skin of the outer conductor / current through the outer skin of the outer conductor

For a finite value of isolation impedance, Z_s, a leakage current flows through R_e, and the resulting voltage drop across r_2 simulates a finite attenuation introduced by the unit under test.

A simple calculation under the assumption that r_1 and r_2 are very small compared to Z_{out}, Z_{in}, Z and Z_s gives:

$$\frac{U_2}{U_o} = \frac{r_1}{Z_{out} + Z} \times \frac{r_2}{Z_s} \times \frac{Z_{in}}{Z_{in} + Z}$$

For the case where $Z_{out} = Z_{in} = Z$, the attenuation "a" is obtained:

$$a = 20 \times \log \frac{U_o}{2 \times U_2}$$

substituting for U_o:

$$a = 20 \times \log \frac{2 \times Z \times Z_s}{r_1 \times r_2}$$

Therefore, this attenuation for instance for a max. measurement error of 0.01 dB must be about 60 dB larger than the attenuation to be measured (for 0.1 dB by about 40 dB) when the worst phase angle between test voltage and error voltage is taken into account.

The isolation impedance, Z_s , comprises a combination of several components, namely the instrument capacitances to earth, the apparent resistances introduced by the remote control cable and power cord as well as the capacitance between the instruments.

These capacitances series resonate with the unavoidable inductivity of the loop formed by the test cable, and the upper frequency limit of the measuring setup determines the isolation impedance value.

However, if the instruments are separated by at least 30 cm, then the capacitance between the instruments can be reduced. As a consequence the resonant frequency can be shifted higher and the magnitude of Z_s does not go lower than 60 Ω (even in remote control operation). If the two instruments are stacked, $Z_s \approx 10\,\Omega$ at the upper frequency limit.

With external control, $|\ Z_s\ | \leqq 100\,\Omega$ over the entire frequency range. This is a result of the coaxial input connectors for the external control cable. The con-

nectors are insulated from the cases of the PS-60/SPM-60, but the outer conductor at Bu 801 of the PS-60 is connected through an attenuation resistor of 100 Ω to the equipment case.

If r_1 and r_2 are assumed to be each 10 mΩ, that is the value of surface transfer resistance for a high quality, double screened coaxial cable 50 cm in length, then with Z = 75 Ω for the configuration of Fig. 3-1, there is an attenuation of 159 dB.

When Measuring Setup PS-60/SPM-60 is used at full accuracy to measure an attenuation of 93 dB (send level + 1 dB, receive level - 92 dB), the calculated value of 159 dB as assumed above leads to an additional inaccuracy of at most 0.01 dB.

If there is no high quality cable available, simple screened cable exhibits surface transfer resistance of 50 to 200 mΩ per meter, or if long lengths of cable cannot be removed, then the isolation impedance can be increased by separating the Generator and Receiver and eliminating the remote control of generator frequency.

3.2. Application examples for the SPM-60 with Control Oscillator OD-600

The Control Oscillator OD-600 permits decadic frequency tuning of the Level Meter SPM-60 with minimum steps of 1 Hz. It is also possible to tune the Level Meter SPM-6 and the Level Generators PS-60 and PS-6 with the OD-600. If the plug-in ODF-601 is also fitted, then up to 26 freely programmable fixed frequencies can be selected. Automatic cycling through the fixed frequencies is possible, with dwell times of 2, 4, or 8 seconds.

3.2.1. Measurement of channel translators

For this measurement with frequency offset, the ODF-601 on the sender side controls the ODF-601 on the receiver side. The frequencies of the ODF-601 on the receiver side are in thise case preprogrammed to a higher or lower offset value corresponding to the conversion frequency.

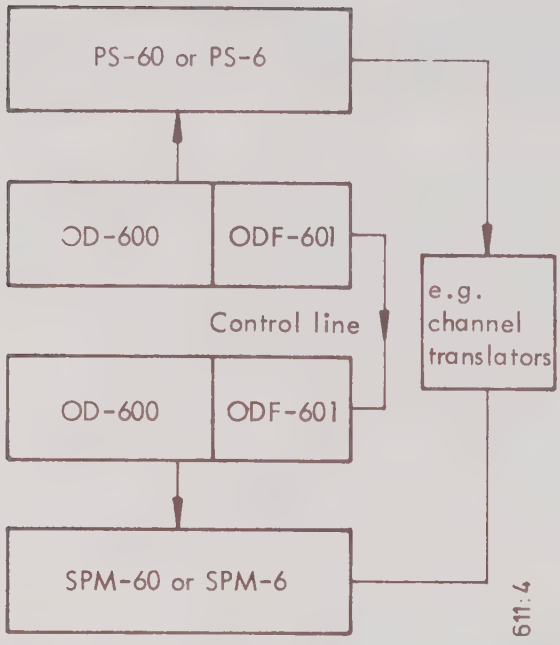


Fig. 3-2 Test configuration for measurement of channel translators

3.2.2. Monitoring on FDM systems actually carrying traffic

Monitoring of FDM systems - and thus early detection of faults - during operation is possible if defined levels are transmitted in the gaps between the channels of the system (interstitial gaps) and received at the remote end. The measuring frequencies used depend on the specific structure of the system and are easily programmed in the Fixed Frequency Plug-ins ODF-601.

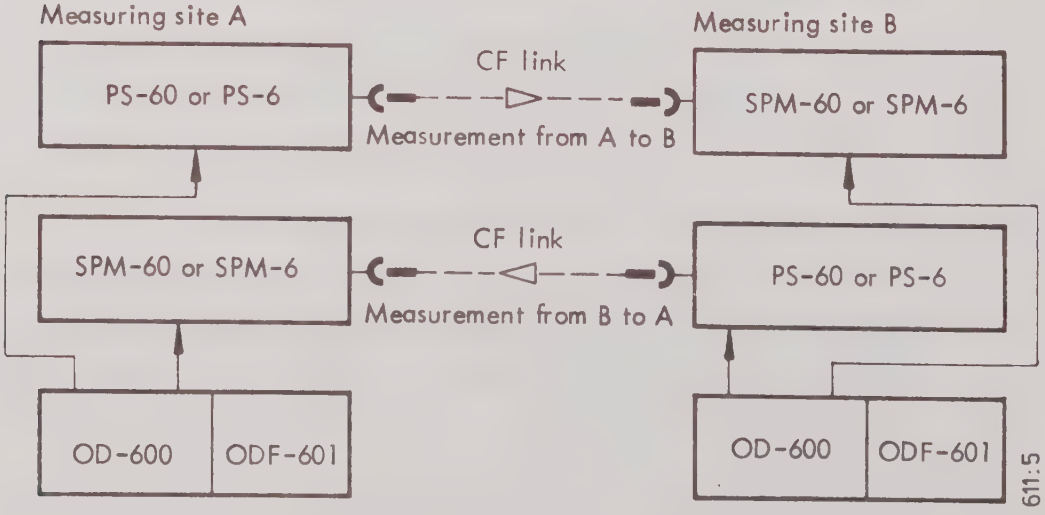


Fig. 3-3 Test configuration

If measurements are to be made only from site A to site B, then the SPM-60 (SPM-6) may be omitted at measuring site A and the PS-60 (PS-6) omitted at measuring site B.

The ODF-601 permits automatically cycled selective link measurements without synchronization measures on the receive side (which means that an additional auxiliary channel is not required). In this case, the ODF-601 on the send side is set to "Automatic stepping". The ODF-601 on the receiver side then synchronizes itself automatically with the incoming frequency.

In order to prevent interference with the in-service FDM system during switching of the output frequency with the ODF-601, the output level of the PS-60 is automatically blanked out and restored again. It is also possible to use this equipment together with the earlier model channel gap test setup KLE-34 (12 kHz to 552 kHz).

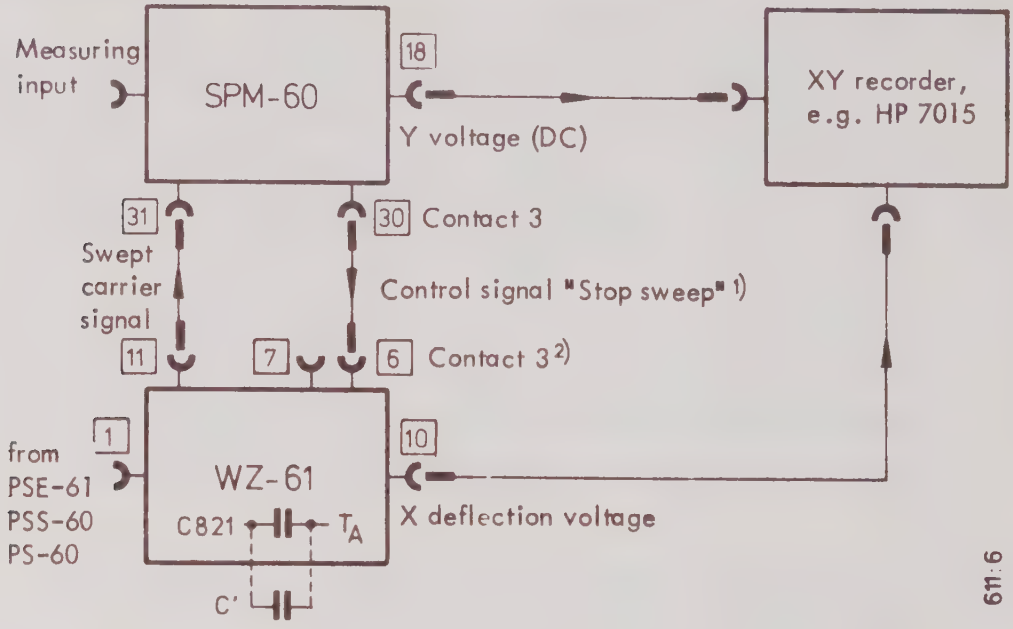
3.3. Sweep operation with sweep adapter WZ-61

The Level Meter SPM-61, with its continuous frequency tuning and the high-speed signal detector as a tuning aid, is suitable for searching for interference lines and excessive levels in transmission systems.

It is necessary, for example, to measure interference levels of - 110 dBm in wideband RF systems. Together with the Sweep Adapter WZ-61, such measurements can be carried out in sweep mode, the result being recorded on an XY recorder. The sweep limits can be set up decadically with minimum steps of 100 Hz on the WZ-61. The sweep time should not be set to less than 50 seconds! In particular for large sweep ranges, an additional extension of the sweep time (up to a maximum of 100 s) by connection of an additional capacitor of type "MKL" in parallel with C 821 in the WZ-61 is advantageous in order to provide sufficient time for the detector in the SPM-60 to process the level differences.

As shown in Figure 3-4, the SPM-60 receives the swept carrier frequency from the WZ-61. The external tuning switch [25] must therefore be set to "on". The output frequency of a signal generator PSE-61 (connected internally in WZ-61), PSS-60 or PS-6/60 (via the overvoltage output) must be connected to the sweep adapter at input [1] for control of the carrier oscillator in the WZ-61 (reversing at the sweep limits). The sweep operation is stopped during the calibration cycle

through a connection from output [30] to the WZ-61. This maintains the high measuring accuracy of the SPM-60 without the loss of information during calibration.



External additional capacitor "MKL", C' = (n - 1) · 10 µF for n times extension of the Sweep time e.g. C' = 190 µF for $T'_A = 20 \cdot T_A = 20 \cdot 50\,s = 100\,s$

Fig. 3-4 Test configuration for searching for interference lines in a transmission system

1) The earth connections are pin 1 of input [30] of the SPM-60 and pin 14 of input [6] of the WZ-61.
2) Input [7] can also be used. However, in series A and B units, pin 3 of input [7] must be connected to pin b1 of board 689-M in the WZ-61 or to pin 3 of input [6]

3.4. Settling behavior of the frequency

The frequency stability of the free-running oscillator in the SPM-60 depends on the ambient conditions, mainly on the ambient temperature (temperature coefficient in the order $10^{-5}/^{o}C$).

When the unit has settled and with a constant ambient temperature, there is practically no frequency wandering.

During the settling phase, a frequency shift can be observed due to the internal heating of the unit. Figure 3-5 shows a typical behavior of the frequency variation after the unit is switched on. These curves are valid for a constant ambient temperature.

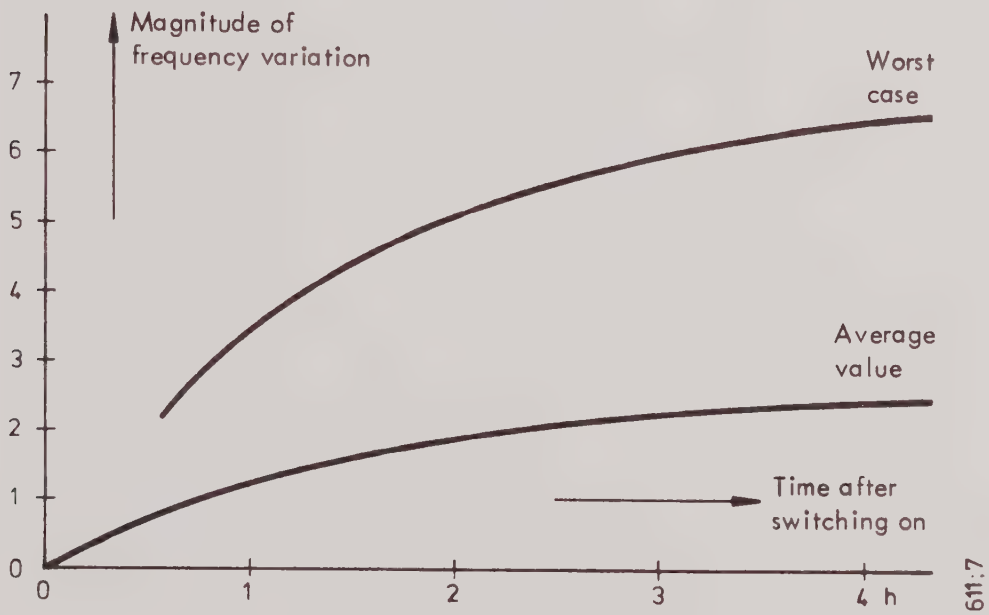


Fig. 3-5 Settling behavior of the frequency the SPM-60 at a constant ambient temperature

4. FUNCTIONS AND CHARACTERISTICS

The Level Meter SPM-60 is a receiver which operates according to the principle of multiple conversion having four different intermediate frequencies (IF's). The last IF is at 10 kHz where the most gain and selectivity is achieved. This signal is then rectified and indicated on a meter.

Simultaneously, the indicated voltage also is presented at a d.c. output connector, and there is no possibility of feedback from the load. An output from the demodulator provides the opportunity of checking single-side-band signals. At two other outputs, there are the signals needed for the remote control tuning of frequencies at the Generators PS-60, PSS-60 or PS-6.

Such high accuracy for measuring levels is attained by means of an automatic calibrator for levels. This operates at a 1 Hz repetition rate. At this rate, the gain is checked at the pertinent tuned frequency and at the level measuring range used at that time. Then, within the same interval, the gain automatically is reset to the nominal value. A push button, for checking, enables a rapid and easy verification to determine if the Level Meter is being overdriven.

This feature prevents errors in measuring when there are large differences in levels at various frequencies presented at the input to the SPM-60.

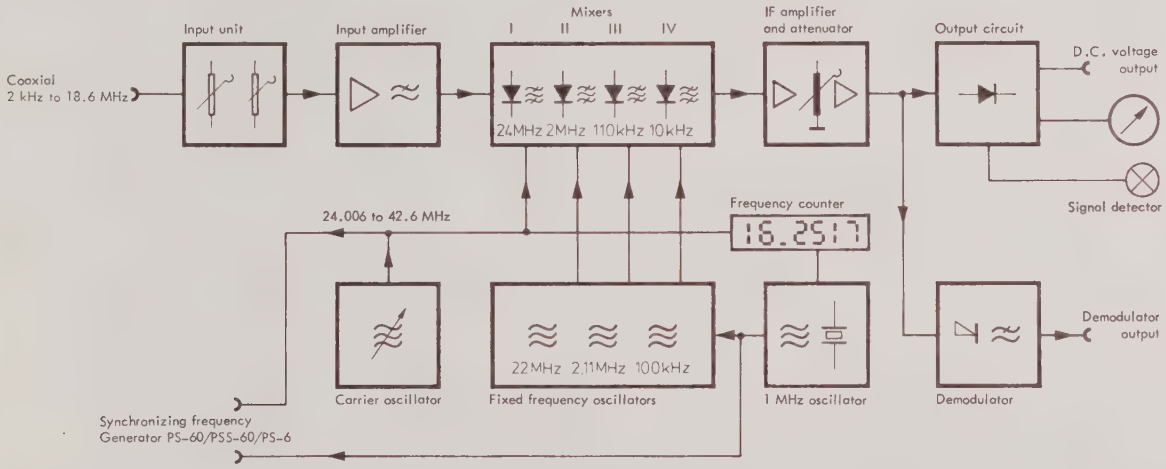


Fig. 4-1

4.1. Automatic level calibration

By means of the automatic level calibration, the long term stability of level measurement is as good as the inbuilt calibration level source whose verification results from the use of a silicon reference element. Thereby, the variation with frequency of the entire equipment, and the attenuator accuracy are reduced to the accuracy of the ratio-transformer type of IF voltage divider. See Fig. 4-2.

Additionally, automatic calibration considerably simplifies operating the Level Meter. The frequency of the calibration source is obtained by down-conversion of the carrier frequency f_T (16) and the frequency f_{ZT} = 24 MHz from PLL cal. oscillator (22), phase locked to a crystal control oscillator. Therefore, the calibration frequency switches alternately for approx. 1 s to "MEASURE" and for approx. 0.1 s to "CALIBRATE". Since the calibration level is fed in before attenuator I, this attenuator and the error due to variation with frequency are included. Simultaneously, during the calibration cycle the extremely accurate ratio-transformer attenuator II is automatically changed accordingly to track with the setting of attenuator. Thus the sensitivity of the entire set always remains the same and independent of the setting of attenuator I. The converted, amplified and rectified calibration signla is then compared to a highly stable reference voltage V_{ref}. IF there are deviations from the nominal gain, probably caused by errors in attenuator I as well as variations with frequency, then an automatic level amplifier takes on the corresponding corrective action. This resetting of the gain does not take place during the next measuring interval, but the ratio-transformer attenuator II automatically is reset to the setting corresponding to the externally adjusted measuring sensitivity of the Level Meter.

From the continuous change-over between "MEASURE" and "CALIBRATE", a small difference of nominal gain results, however, this is virtually negligible because of the high accuracy of attenuator II. A memory circuit retains the readout at the last result from the previous measuring interval, thus the level readout is not disturbed by the calibration process. During the calibration interval, a substitute load is at the input of the Level Meter, so the return loss coefficient is not changed during this time.

4. FUNCTIONS AND CHARACTERISTICS

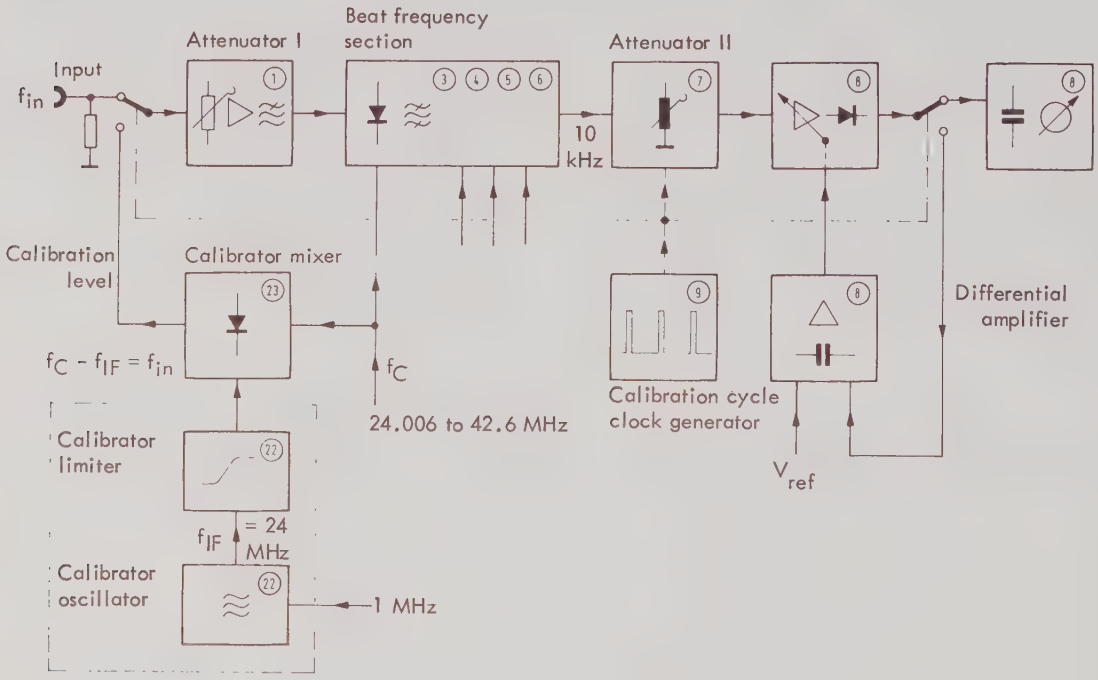


Fig. 4-2

4.2. Overload control

After the OVERLOAD control push button is actuated, with the start of the next calibration cycle at the input to the Level Meter, the gain is raised by about 1 dB. In the same rhythm, the gain in the 10 kHz amplifier is decreased by the same amount, so in fact the overall gain remains constant: input amplifier and mixer, however, are driven by 1 dB higher level.

When the Level Meter is operating linearly, the level reading does not change in the succeeding measuring interval, but if the Level Meter is overdriven, then the level reading increases. If the OVERLOAD push button is depressed for a short time, then the OVERLOAD check results during the next measuring interval.

With a continuously depressed push button, the OVERLOAD check takes place every second measuring interval. An overdriven condition (OVERLOAD) manifests itself as a periodic fluctuation at a 2 second rate.

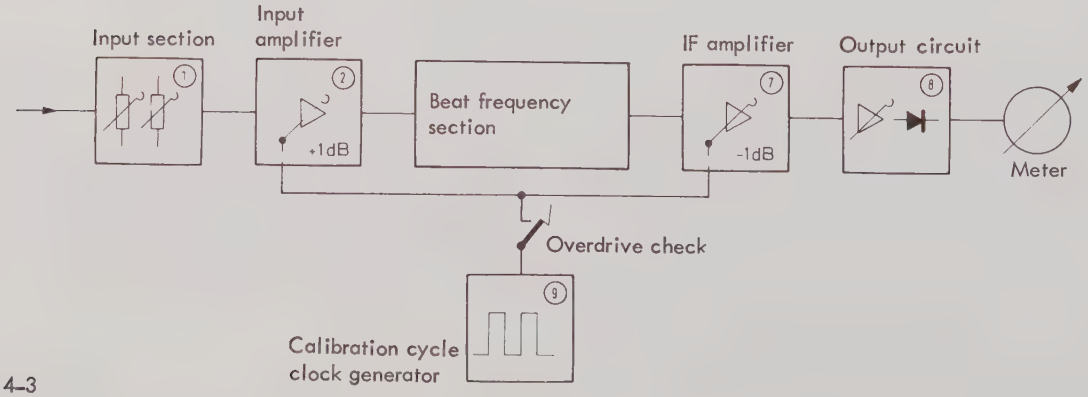


Fig. 4-3

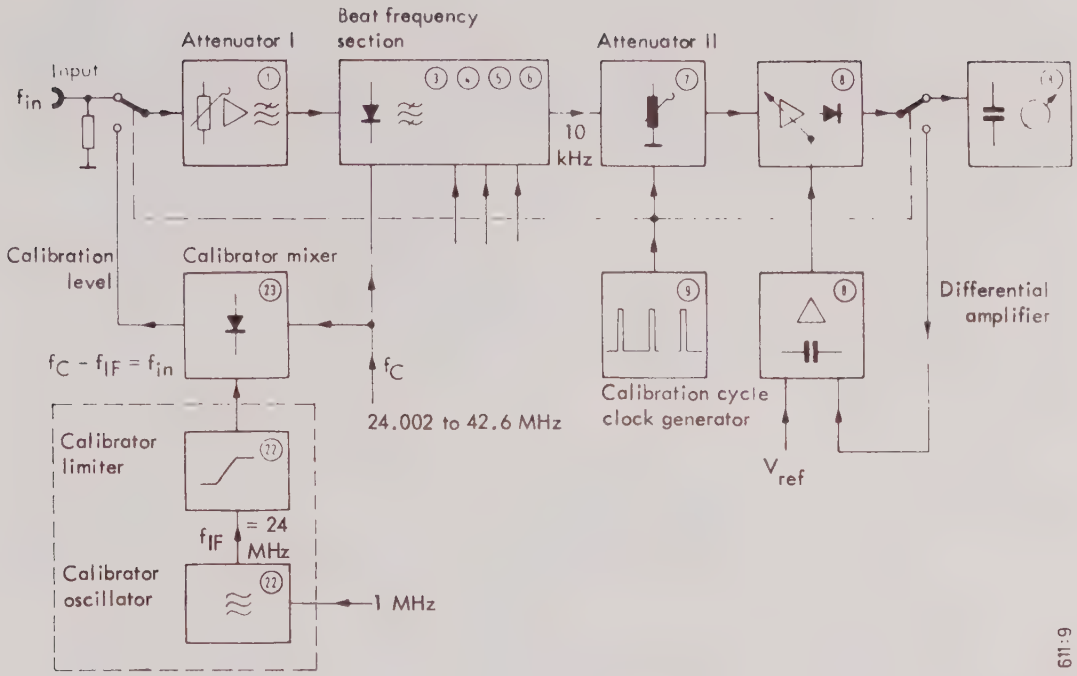


Fig. 4-2

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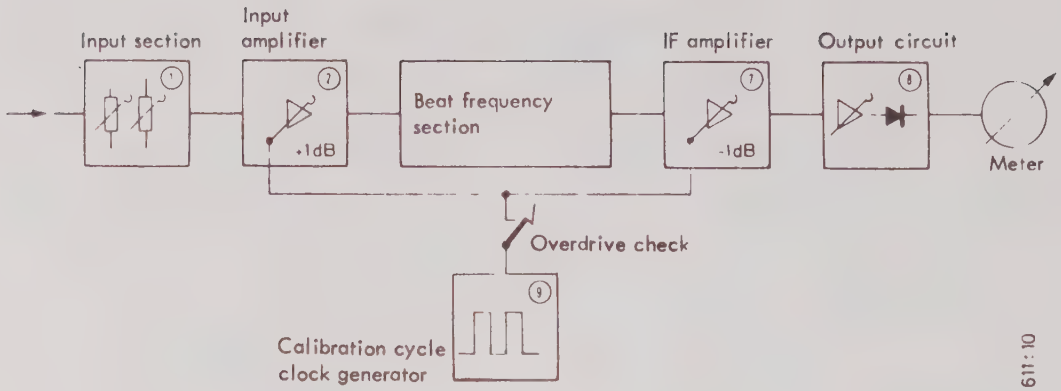


Fig. 4-3

4.3. Frequency generation

The carrier frequency f_T, tunable from 24 to 42.6 MHz, is used to control the first mixer. It is derived from tripling the control frequency f_{St} which is continuously tunable in the range 8 to 14.2 MHz due to the LC control oscillator.

Tripling is done with the aid of a phase locked loop (PLL) whose tracking range magnitude is formed by the control oscillator. Thus, the carrier frequency is divided in the ratio 3 : 1. Then it is compared with the control frequency in a phase comparator circuit whose output voltage is proportional to both frequencies and stabilizes the carrier oscillator at $f_T = 3 \times f_{St}$.

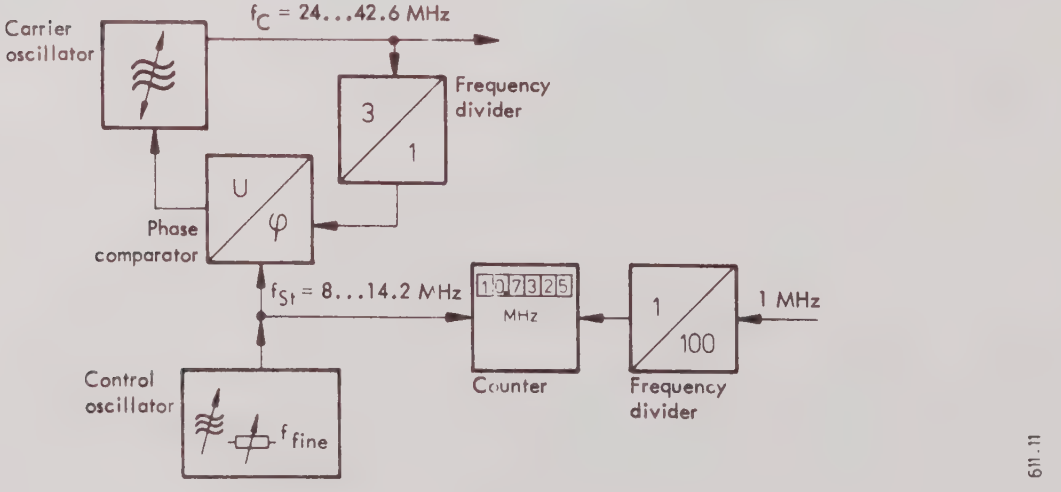


Fig. 4-4 Simplified block diagram of the carrier frequency generation

4.4. Frequency readout

Readout of the set-in frequency is done at the 6 digit numeric display of the crystal controlled frequency counter. To ensure that the frequency is always correctly displayed in the utilized frequency range of 2 kHz to 18.6 MHz, the preselection and open gate time of the counter must be correspondingly chosen. The measuring interval is obtained from dividing the crystal controlled 1 MHz oscillator frequency. The number of measurements per second is correlated with the resolution as follows:

Resolution: 1 kHz (5 digit readout) 80 measurements/s
Resolution: 100 Hz (6 digit readout) 8 measurements/s
Resolution: 10 Hz (6 digit readout) 3 measurements/s
+ decimal point shift

The counter essentially comprises along with the time-base and counter control of the counting circuit, the buffer, decoder/driver and the digital readout display. A prominent feature is the flicker-free numeric display of frequency. A new circuit eliminates the flicker, but with 10 Hz resolution when the push button is depressed, the circuit is inoperable.

4.5. Output circuit / signal detector

A fast signal detector permits an LED to indicate the presence of both a signal voltage at the measurement input and also within the indication range of the analog meter. This results from the 10 kHz IF voltage whose amplitude is a function of the adjustable gain amplifier. The gain is adjusted when the meter scale is selected. The amplifier output is fed to a meter detector. Furthermore, the positive half-waves control a Schmitt trigger circuit whose output signal toggles a monostable circuit which conducts for 100 ms (approx.) during which the LED is lit.

4.6. Frequency locking circuit

The frequency locking circuit comprises mainly a frequency and phase control loop and the control logic.

A continually shiftable line spectrum is derived from a voltage-controlled crystal oscillator (27) by frequency division in order to permit locking at any frequency

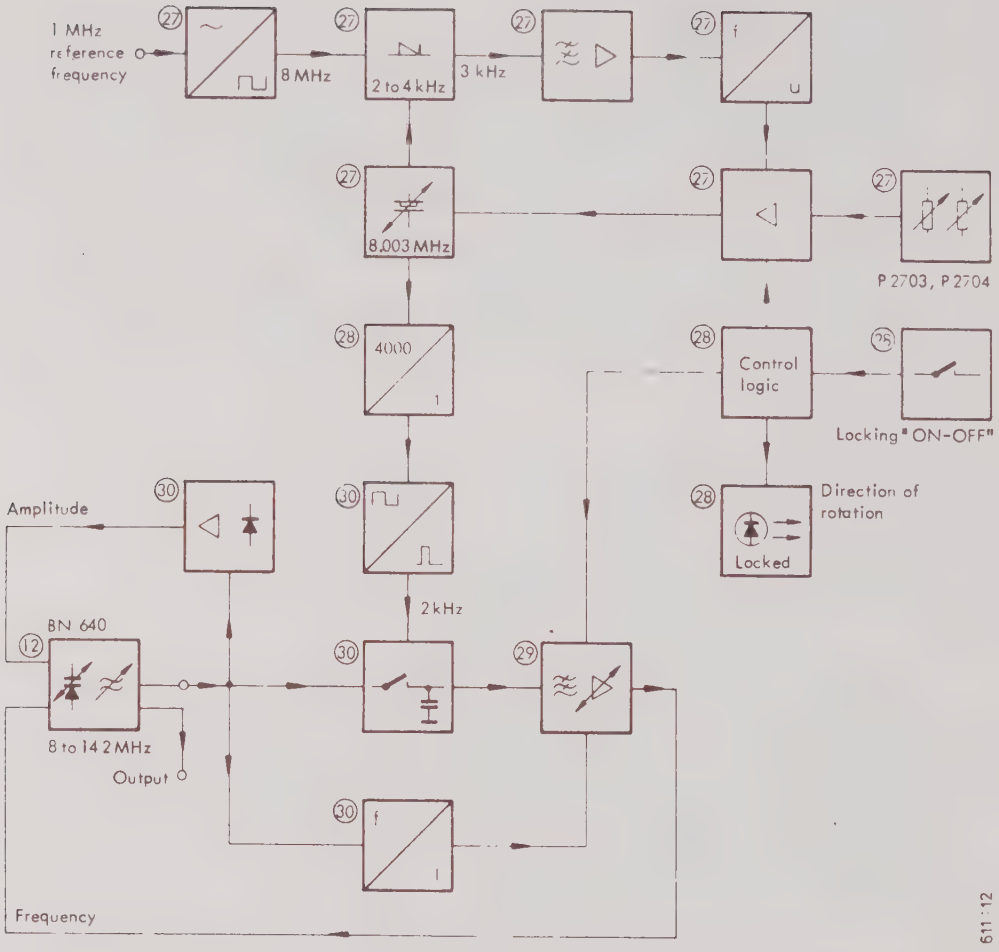


Fig. 4-5

and not only at fixed frequencies. The displacement width is greater (≧ 7 kHz) than the line spacing (6 kHz or 2 kHz).

The line spacing of 6 kHz is referred to the tuning of the complete unit and thus to the carrier oscillator (16) . Due to the type of carrier generation in the SPM-60, the control oscillator (12) operates at one-third of the carrier frequency, which means that the line spacing is also one-third, namely 2 kHz, referred to the control oscillator.

The locking circuit contains a sampling phase meter (30) , which at 2 kHz sampling frequency, samples the control oscillator frequency (12) and adjusts the frequency of the control oscillator with the voltage derived from this phase comparison, after suitable amplification and filtering in the equalization amplifier (29) .

The phase comparison circuit operates as a phase meter whose output voltage, however, is dependent not only on the sampled phase but also on the amplitude of the input AC voltage. As the line spectrum, referred to the tuned frequency, should be shiftable, the sampling frequency, and thus the 8 MHz quartz oscillator must also be tunable.

During locking, the following steps occur in the locking circuit:
The lock switch is set to "Off", the phase control loop (Control oscillator (12), sampler, and equalizing amplifier) is electroncally disconnected, the sampling pulse is blocked, the capacitance diode in the control oscillator (12) is connected to a fixed DC voltage, the crystal oscillator in the frequency control circuit (27) operates close to its lower limit. When the lock switch is switched on, the phase control loop remains switched off and the capacitance diode remains connected to the fixed DC voltage.

After this, the sampling pulse is released and a ramp shaped sweep voltage (for a single cycle) is connected to the control input of the 8 MHz crystal oscillator in (27), thus shifting the line spectrum upwards, starting at the lower frequency limit, over a period of approximately 1.5 s. During this automatic search, the instantaneous frequency difference between the fixed input frequency (12) and the swept line frequency is measured with the aid of a frequency evaluation circuit at the output of the sampler and the sweep operation is stopped abruptly when the two frequencies are approximately equal, i. e. when the output frequency is close to zero (less than 110 Hz). Depending on the amplitude of the poteniometer voltage compared with the stored required value, one of the two LED's showing direction of rotation is activated to show the direction in which the spectral lines have to be shifted to make them coincide with the frequency to be locked.

In the locked state of the control loop, a monitoring device is active to monitor the output of the sampler and to check the correct locked state. If the fine detuning potentiometer is moved in the locked state, the closed control loop ensures that the frequency of the control oscillator immediately follows the spectral line, i. e. the control loop remains locked.

5. MAINTENANCE AND GENERAL INFORMATION

Danger: Before the cabinet is opened, the a.c. power line should be disconnected

5.1. Mechanical assembly

The cabinet dimensions correspond to the new DIN Standard 41 494 and the USA Standards, RETMA, as well as ASA C 83.9. Accordingly, the equipment can be mounted in a 19" rack.

Cover, base plate, back panel and side panels are manufactured out of plastic covered aluminium sheetes. After removal of the corresponding screws on the back panel, the chosen panel can be pulled out backwards. Thereupon, the switches and circuit elements are accessible. In order to obtain access to the subassemblies at the centre of the equipment, subassemblies (6), (7), (8), (9) and (26) are fabricated on a folding subchassis, and after removal of two screws and the drive coupling, the subchassis may be unfolded outwards.
If the chassis must be completely removed for instance to change components, then only a "Subminix" plug as well as a multi-pin Amphenol plug and the right hanger (hinge) need be removed.

5.2. Switch maintenance

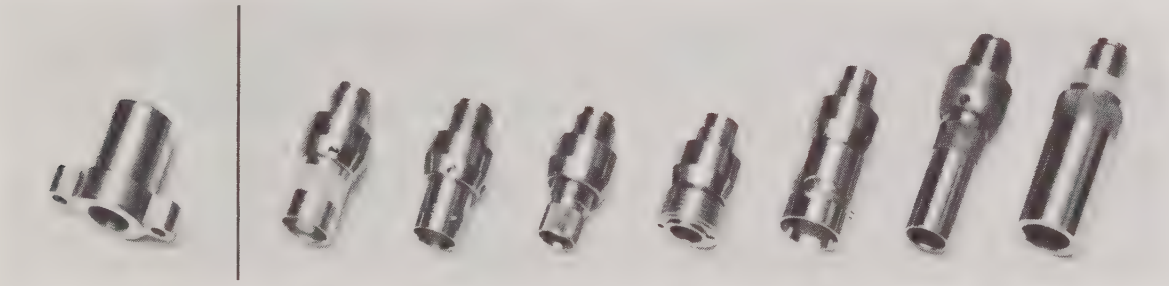
To prevent mechanical wear at the switch, the indents should have periodic reapplication of switch lubricant.

5.3. Changing fuses

The fuse holder is located on the back panel of the equipment. After the cap has been unscrewed, the fuse is accessible and can be exchanged. Make sure that the correctly rated fuse is replaced! See paragraph 2.2.2.

5.4. Universal connectors Versacon® 9

The coaxial input and the control outputs for remote control of the PS-60, PSS-60 or PS-6 are fitted with the new Universal connectors of Wandel u. Goltermann. These have the advantage that adaptors can be changed quickly for the connector types listed below. No resoldering is needed, only a mounting wrench is used (order number W1).



Versacon® 9 | Lemo | BNC | 1.6/5.6 | 2.5/6 | 1.6/10 | 558A | 470C Western Electric

Fig. 5-1

5.5. Mounting in a 19" rack

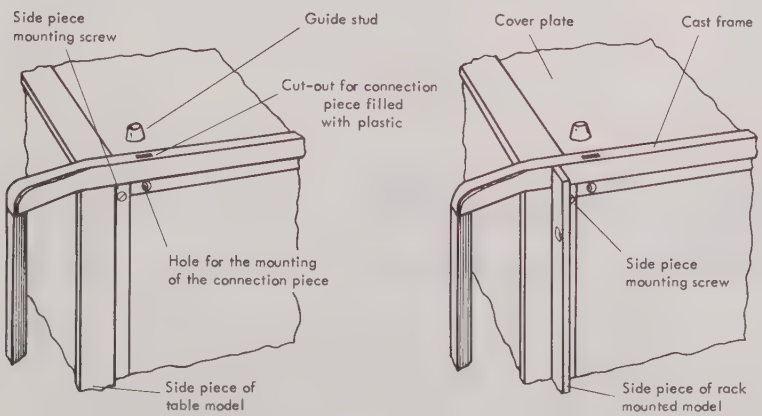

Side piece mounting screw
Guide stud
Cut-out for connection piece filled with plastic
Hole for the mounting of the connection piece
Side piece of table model
Cover plate
Cast frame
Side piece mounting screw
Side piece of rack mounted model

Fig. 5-2

5. MAINTENANCE AND GENERAL INFORMATION

If the equipment is to be mounted in a standard 19" rack, then the side pieces of the case frame must be replaced with special mounting brackets order number BN 556/4. The front panel dimensions are increased in width to that of the mounting dimensions for a 19" rack. After removal of two screws (see Fig. 5-2), the side pieces of the case can be exchanged for the brackets.

Cover and base plate are removed, then the feet and guide studs are removed. Side panels, cover and base plate are replaced and the screws are tightened.

5.6. Combining several equipments

The new cabinet conception allows the mounting of several instruments, one above the other. These instruments are firmly mounted together by means of special connection pieces, order number 00-0400.06/5.

To do this, it is necessary to remove the cover of the lower instrument and the base plate of the upper instrument as well as the side panels of both. The small plastic pieces in the frame cut-outs are now pushed out. This is done for the four cut-outs of the upper frame and the four cut-outs of the lower frame.

The four connection pieces are placed into the cut-outs of the lower instrument as shown in Fig. 5-3 and are screwed firmly into place. After removing the guide studs from the cover and the foot pieces from the base plate, both panels should be replaced.

The instruments are now placed one above the other so that the connection pieces, mounted in the frame of the lower instrument pass through the frame cut-outs of the upper instrument. After firmly screwing the upper instrument to the connection pieces, the side panels should be replaced.

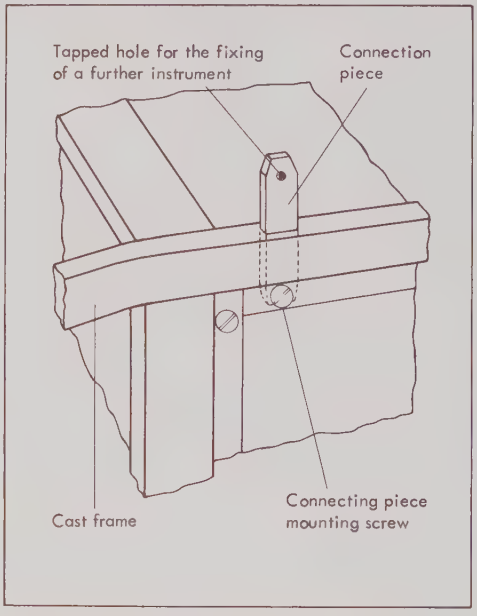
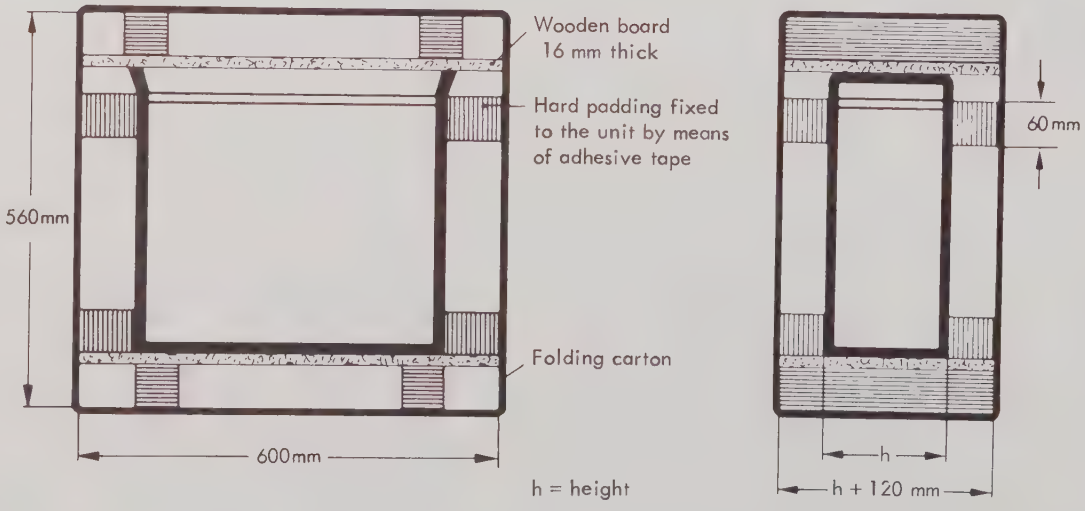


Fig. 5-3

5.7. Shipping instructions

Safe transportation of the equipment used in Measuring Set RK-5 can only be guaranteed if adequate packing is used. If the original packing has been discarded, the equipment should only be packed as shown in the following drawing, Fig. 5-4.



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The four connection pieces are placed into the cut-outs of the lower instrument as shown in Fig. 5-3 and are screwed firmly into place. After removing the guide studs from the cover and the foot pieces from the base plate, both panels should be replaced.

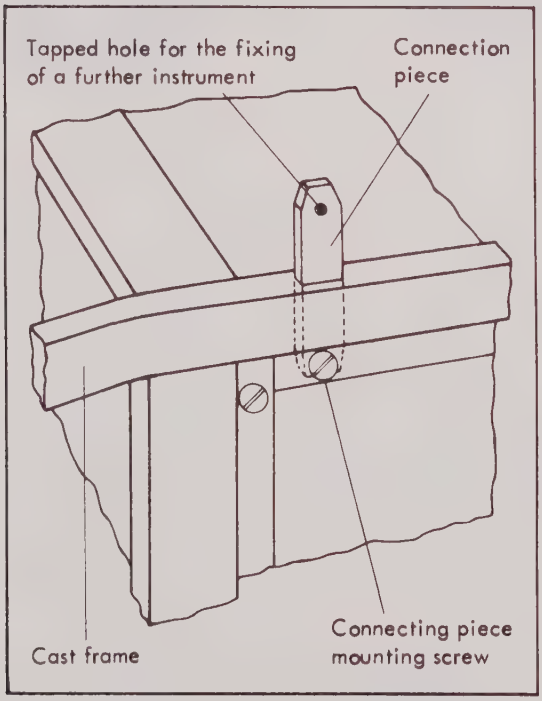


Fig. 5-3

The instruments are now placed one above the other so that the connection pieces, mounted in the frame of the lower instrument pass through the frame cut-outs of the upper instrument. After firmly screwing the upper instrument to the connection pieces, the side panels should be replaced.

5.7. Shipping instructions

Safe transportation of the equipment used in Measuring Set RK-5 can only be guaranteed if adequate packing is used. If the original packing has been discarded, the equipment should only be packed as shown in the following drawing, Fig. 5-4.

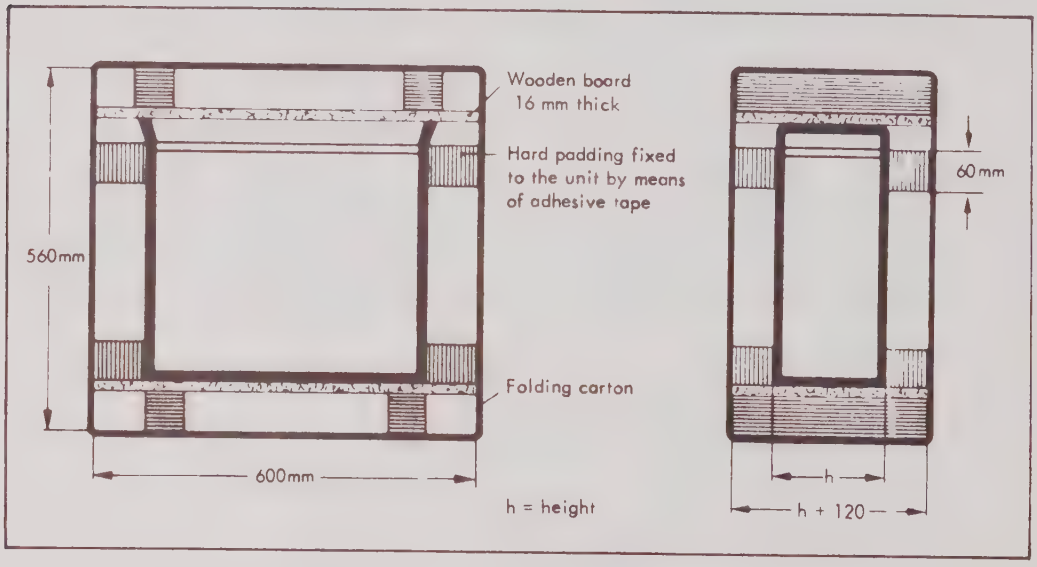


Fig. 5-4

5.8. Functional check of the Level Meter

The following details permit checking of the correct function of the SPM-60. The user can thus check that the unit has no coarse errors (e. g. transport damage). The following test equipment is recommended:

1 Multimeter	e.g. UM-1	AEG
1 Milliwatt Test Set	EPM-1	W&G
with Test Probe	TK-10	W&G
1 Attenuator 9.03 dB	BN 594/1	W&G
1 T adapter	BN 4851	Spinner
1 Variable attenuator 75 Ω	D 120	Siemens
1 Oscilloscope	PM 3250	Philips
1 Frequency Counter	FZ-4	W&G
1 Signal Generator	PS-60	W&G

5.8.1. Mechanical zero of the meter

Switch off the SPM-60 and check that the meter needle lies on the black triangle "▼". Correct if necessary.

5.8.2. Check of the supply voltages

The voltages can be measured on the plug connector in the power supply (lower side of the unit), with respect to the earth socket (front panel).

Required values at

Point R	approx. + 180 V
Points 1 ... 8	+ 12 V, adjustable with P 2501
Points A ... J and S	- 12 V, adjustable with P 2502
Points 9 ... 12	+ 5 V, adjustable with P 2503

The ripple on the regulated voltage of + 12 V, - 12 V, and + 5 V should not exceed V_{pp} = 5 mV.

5.8.3. Check of the selectivity

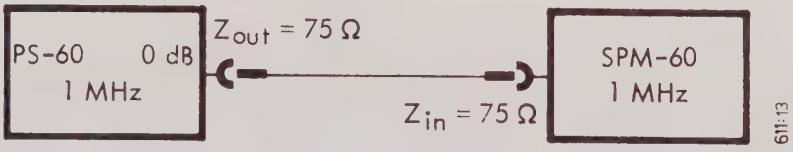


Fig. 5-5

Tune the SPM-60 to precisely 1 MHz with the aid of the counter. Then tune the signal generator to the same frequency and adjust the output level for a 0 dB indication on the SPM-60.

	Δf	
Δa	narrow	wide
≦ 3 dB	250 Hz	1.15 kHz
≧ 30 dB	1 kHz	
≧ 60 dB	2 kHz	2 kHz

Do not change the receive frequency of the SPM-60. Detune the signal generator frequency by ± f as shown in the table above and check whether the corresponding attenuation values a can be measured on the SPM-60.

5.8.4. Check of the frequency response

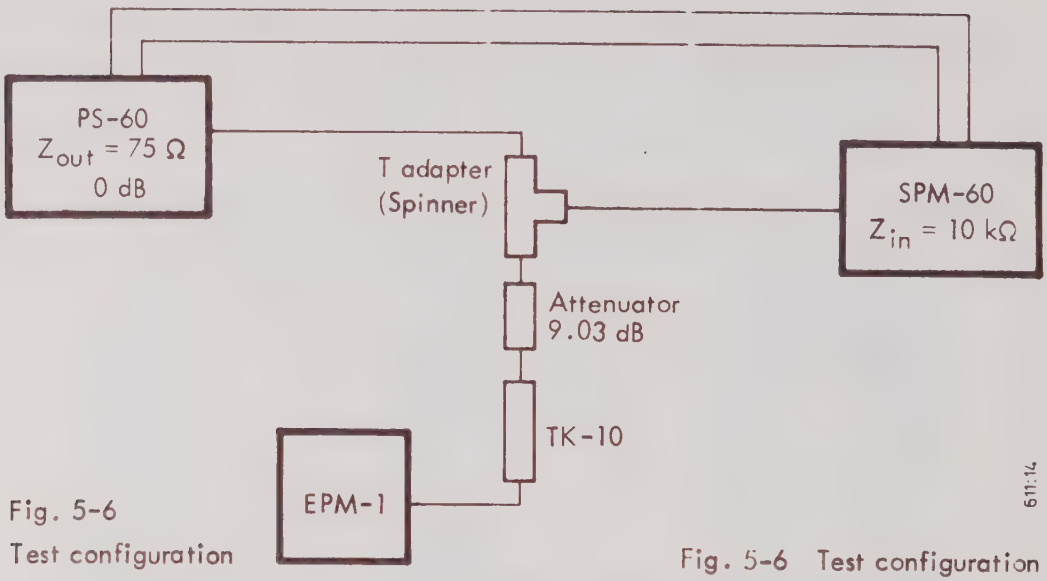


Fig. 5-6
Test configuration

Fig. 5-6 Test configuration

Connect the T adapter and the 9.03 dB attenuator directly to the input of the SPM-60 and use a short piece of 75 Ω cable between the signal generator and the T adapter.

The reference frequency is 20 kHz. With the aid of the EPM-1, keep a constant level of 0 dB at the input of the SPM-60. The deviations from the required value can be read off on the meter of the SPM-60. Use the measuring range ± 0.5 dB and set it to the reference mark at 20 kHz.

The permissible deviation between 6 kHz and 18.6 MHz should not exceed ± 0.15 dB, and the deviation between 20 kHz and 6 MHz should not exceed ± 0.1 dB.

5.8.5. Check of level calibration

Use the test configuration shown in Figure 5-6, but remove the remote control lines. After calibration of the EPM-1, set the output level of the PS-60 to exactly 0 dBm on the EPM-1 (measuring frequency 20 kHz). Then check whether the indication of the SPM-60 in measuring range 2 dB is correct and adjust it with P 2504 if necessary.

The DC voltage at test point TP 804 should then be approximately + 2 V. If it deviated greatly from this value, adjust to approximately + 2 V with P 701.

5.8.6. Check of the attenuator (functional check)

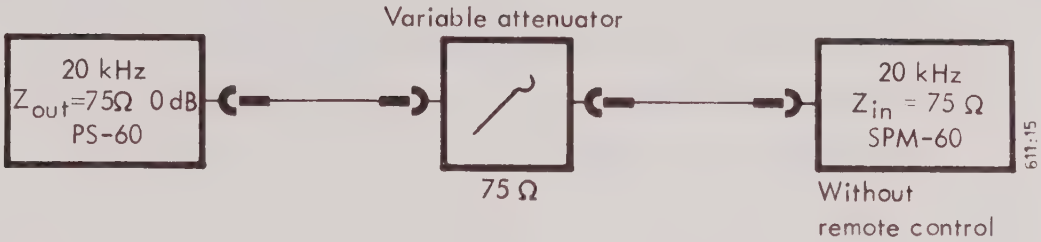


Fig. 5-7

With the variable attenuator set to 0 dB, adjust for a 0 dB signal generator output such that it indicates at the reference mark on the SPM-60 (range ± 0.5 dB). Then change the settings of the variable attenuator and of the attenuator switch on the SPM-60 in 2 dB steps and check the indication on the SPM-60. The indicated deviation is the cumulative error of the divider and of the variable attenuator.

Check for faulty operation of the switch contacts.

5.8.7. Check of scale linearity

Use the test configuration shown in Figure 5-7.
Measure as described in Section 5.8.6.
However, the divider switch of the SPM-60 remains in the initial position and the measuring range is set to 20 dB.

Switch the values of the variable attenuator and check the deviation of the indication from the required value. The indication error is the cumulative error resulting from the scale linearity error and the errors of the variable attenuator used.

Permissible deviation in the range 20 dB ≙ ± 1 % of full scale value
in range 2 dB: ≦ ± 0.03 dB
in range ± 0.5 dB: ≦ ± 0.015 dB

The fast signal detector should light at approx. - 2.1 dB in the 2 dB range and at approximately - 20 dB in the 20 dB range.

5.8.8. Check of the internal standard frequency

Connect an oscilloscope to TP 1102 and compare the internal frequency with an external standard (1 MHz) with the aid of a Lissajous figure.

Required value: $\leqq 3 \cdot 10^{-6}$

Adjustment facility: C 1102

5.8.9. Check of external tuning

Connect the output of the PS-60 to the input of the SPM-60 and tune both units to the same frequency, for example at 0 dB, until the SPM-60 indicates the maximum level.

(Remote control is not yet switched on).

Then establish the remote control connections and set switches [10] and [11] on the PS-60 to the appropriate positions.

The frequency display on the PS-60 is switched off. The level display on the SPM-60 must remain unchanged. If the SPM-60 is detuned, the display on the receiver must not disappear.

5.8.10. Check of the frequency and of the display

Remotely control the PS-60 by means of the SPM-60. Tune the frequency through the whole range and check, with an external counter at the signal generator output, whether the output frequency corresponds to the counter indication on the SPM-60. Check that all digits are correctly displayed. Set the crank knob to the position "fine" and check whether the 100 Hz position is displayed. After this, check the function of pushbutton [4].

The fine frequency control [5] has a range of approx. 600 Hz at 100 kHz, approx. 1.6 kHz at 10 MHz, and approx. 3.4 kHz at 18.6 MHz.

Selective Level M

Operating In

Series

LEVEL INDICATION

The SLOW setting causes damping of the meter movement.

The scale range change-over switch selects the chosen meter scale.

The analog meter movement has 3 scales with the ranges - 2.2 to 0.3 dB, -20 to + 1 dB and - 0.5 to + 0.5 dB (level magnifier).

Measured level = set-up measuring range + meter reading in position "2 dB" or "20 dB" of the scale range change-over switch.

In the position "± 0.5 dB" of the scale range change-over switch, any of the values appearing in the scale range - 2.2 to + 0.3 dB can be adjusted to be at the 0 dB mark on the centre of the lower scale.

CALIBRATION CYCLE STOP

Push button, when depressed, causes calibration cycle to be switched off.

If the input signal disappears, then the calibration cycle is switched off and the SPM-60 switches to the position "MEASURE".

BANDWIDTH CHANGE-OVER SWITCH

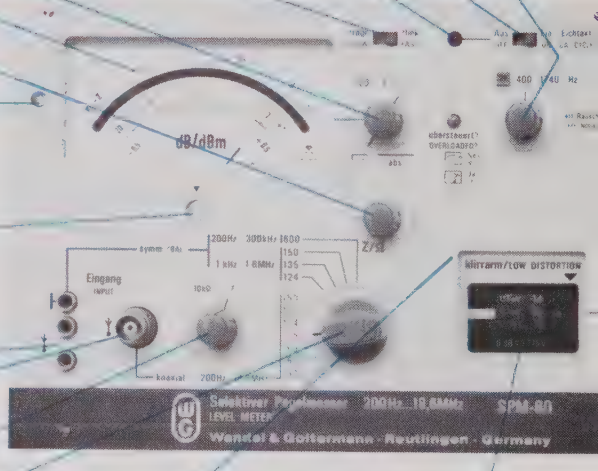
Change-over of equivalent-noise bandwidth between 400 Hz and 1.74 Hz. If requested, 24 Hz is additionally available.

FAST SIGNAL INDICATOR

Tuning aid for finding unknown frequencies. Lamp lights as soon as the input level occurs within the indication range of the analog meter.

MECHANICAL ZERO SETTING

Set to mark " ▼ " when equipment is OFF.



INPUTS

For balanced test specimen measurements only with BN 611/6 and /8, in frequency range 200 Hz (2 kHz) to 1.6 MHz.

f = 200 Hz only with 24 Hz filter

For unbalanced (coaxial) test specimens in frequency range 200 Hz (2 kHz) to 18.6 MHz.

f = 200 Hz only with 24 Hz filter

INPUT IMPEDANCE

Setting $Z_{in} \approx 10$ kΩ; input, high impedance. Permissible d.c. voltage ≦ 42 V.
Setting $Z_{in} = Z_o$; input terminated with impedance selected.

Input impedance of the Level Meter in versions BN 611/6 and /8 may be switched to usually used values; Versions BN 611/0 an /5 are for $Z_o = 75\ \Omega$.

OVERLOAD CHECK

Actuating the push button causes Level Meter to be checked for over driven conditions due to measuring signal. When over driven, the level indication varies at a periodic rate. Then the measurement range must be changed

MEASUREMENT RANGE

Voltage values are valid for meter reading of 0 dB

Settings in - 110 dB o

Low distortion measuring ranges are with a white bar.

CONNECTIONS ON THE BACK PA

A.C. power line connector.

Control outputs for tuning of PS-60/ input.

D.C. Voltage output: the voltage reading.

ter SPM-60

ructions

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TAGE LEVEL/POWER LEVEL
NGE-OVER ⚠

rence value dB / dBm appears in scale
cator window. With BN 611/6 and /8,
ddition remove left side panel, and
ate S 103 located below subassembly (2)

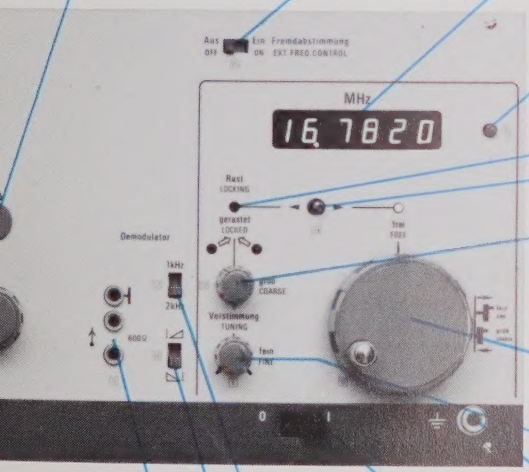
EXT. FREQ. CONTROL

Changeover to external tuning through Control Oscillator OD-600.

FREQUENCY READOUT

5 digits with frequency setting "coarse", resolution 1 kHz
6 digits with frequency setting "fine", resolution 100 Hz

When push button is depressed : 6 digit readout with resolution 100 Hz, or 10 Hz through decimal point shift.



ON-OFF switch
FREQUENCY LOCK

(only with BN 611/5 and /8)

The green indicator lamp illuminates when the frequency is locked.

Change-over between FREE and LOCKED frequency setting.

FREQUENCY OFFSET

Direction of rotation when red →
Direction of rotation when red ←

Continue rotating knob until the lamp is extinguished and LOCK indicator illuminates.

FREQUENCY TUNING

Continuous setting in 1 range
"fine tuning" when knob is pulled out to utilize lower mechanical gear ratio

Detuning only with locked frequency

Upper coarse detuning: range 7 kHz
Lower fine detuning: range approx. 70 Hz of special advantage when 24 Hz filter is in use.

DEMODULATOR OUTPUT

Demodulation mode is switchable:
= upper sideband
= lower sideband

Analog meter remains switched in. Calibration cycle is switchable at calibration cycle stop switch.

A.C. POWER LINE SWITCH

0 = OFF, I = ON

EARTHING TERMINAL

Terminal and case are connected to ground of a.c. line.

dBm

ed

/PS-6 Ext. FREQ. control

tional to the analog meter

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